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IN TWO SECTIONS • SECTION ONE

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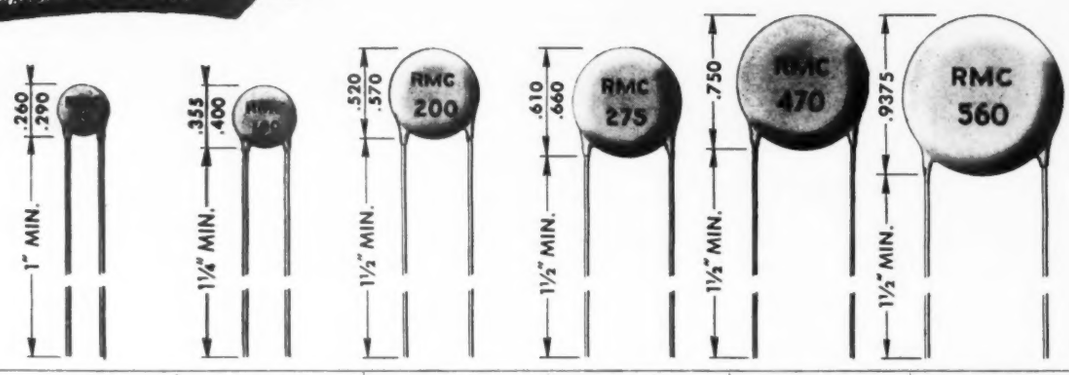

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FRONT COVER: $4.4 BILLIONS FOR ELECTRONIC EQUIPMENT—How the $4.4 billion military budget for radio-electronic equipment will be divided among the military services during the calendar year of 1952. TELE-TECH's estimates, based on authoritative information, reveal that the Air Force will obligate $2.2 billion for radio-electronic equipment in 1952; Navy will obligate $1 billion; Signal Corps will obligate $1.2 billion. See pages 36, 37 for complete details,—also TELE-TECH's Military Radio-Electronic Procurement Chart sent you as Section Two of this issue.

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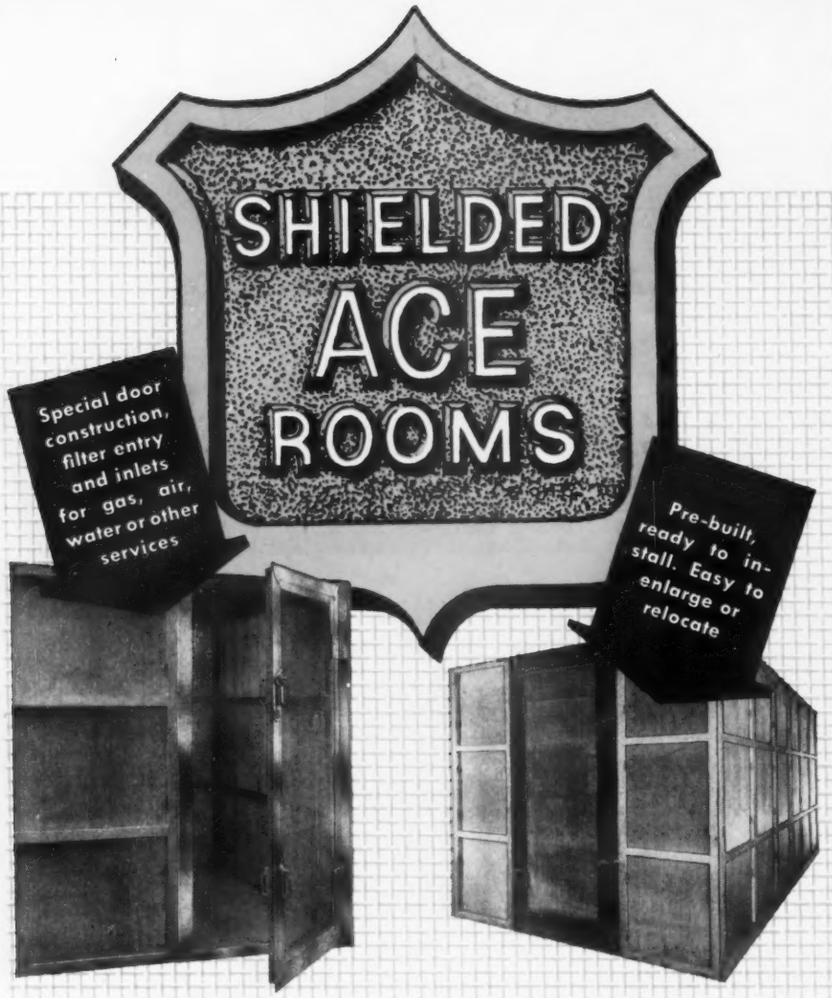
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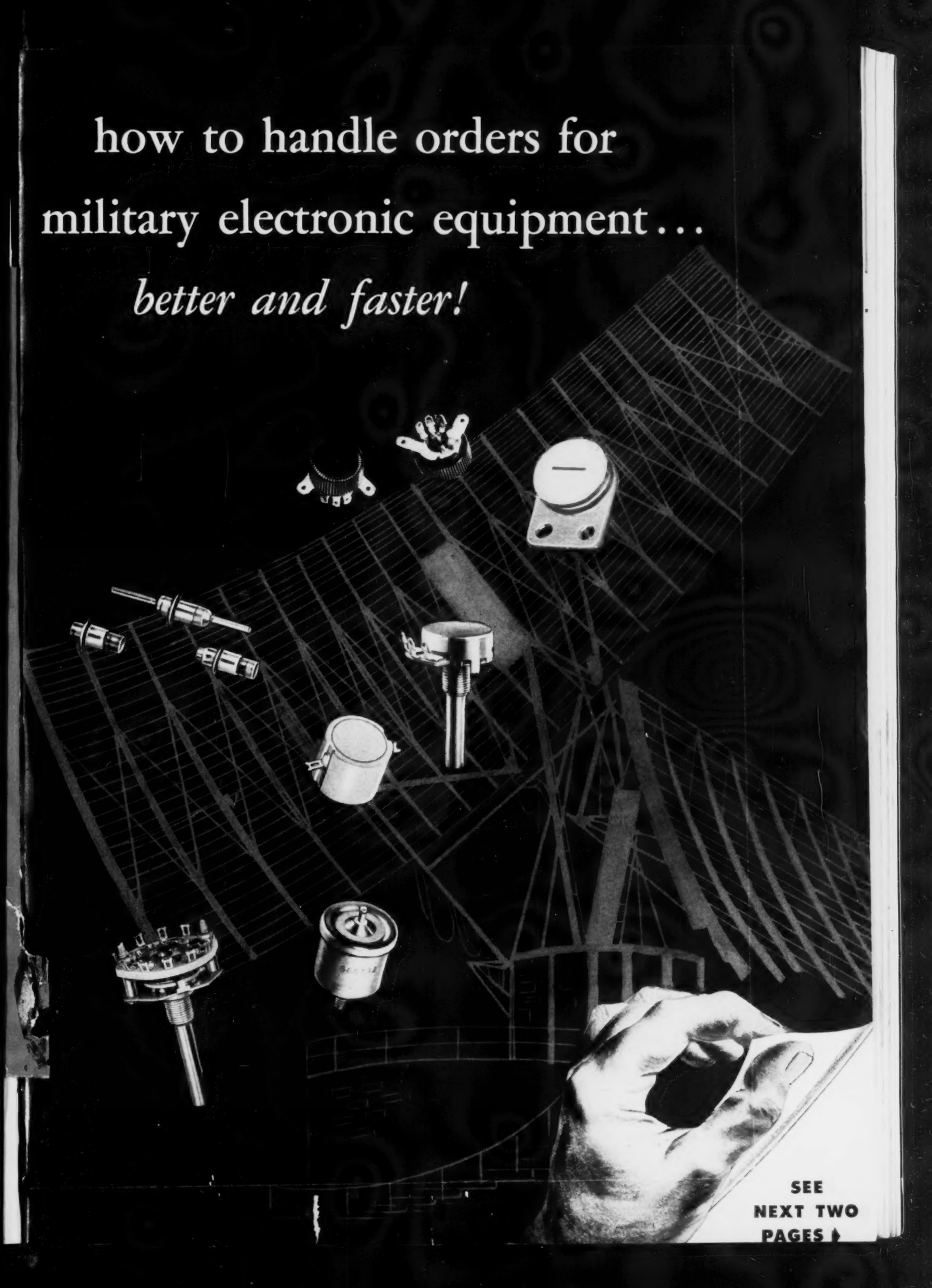

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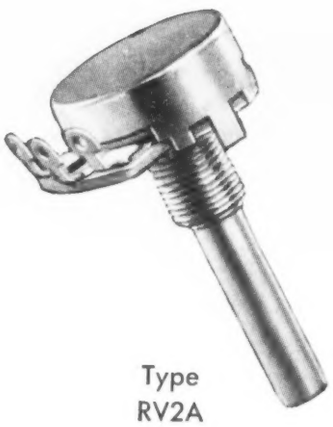
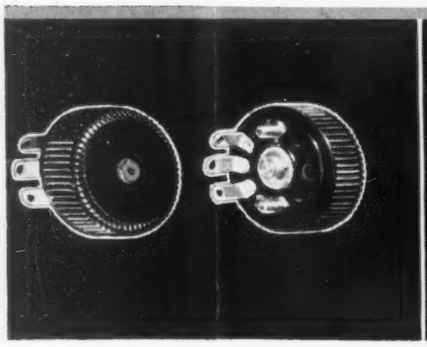


Type RV2A

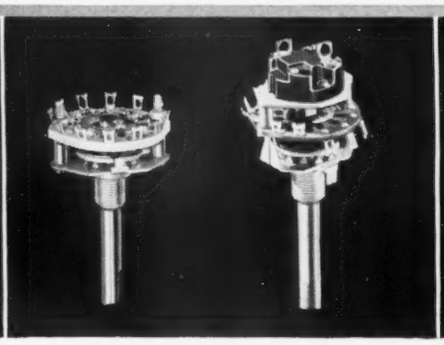
Type RV2B

CENTRALAB MODEL 2 VARIABLE RESISTORS

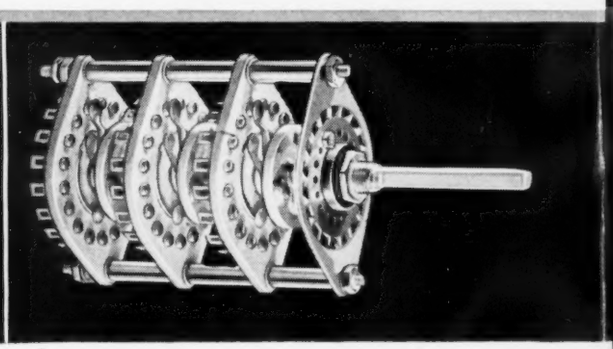
There's no prior contract approval or waivers required if you specify Centralab's Model 2 variable resistors on your next military order. They meet JAN R94, characteristic U requirements. Two types available — RV2A and RV2B — plain or with attached switches. Ratings from 2000 ohms to one megohm. For complete engineering data, check Bulletin No. 42-85 in coupon below.



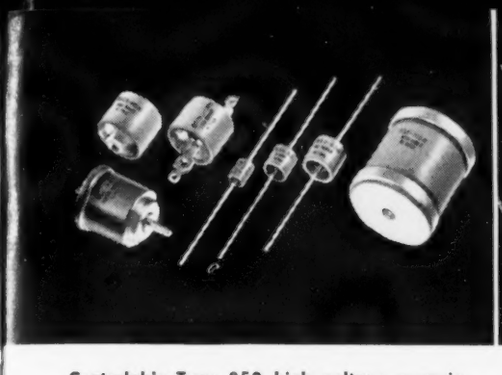
Model 1, miniature variable resistors . . . no bigger than a dime . . . available in Standard or Hi-torque types. Either with or without on-off switch. Also available with slot — front or rear — for screw-driver adjustment. Hi-torque units hold settings under conditions of vibration or shock. For complete data check No. 42-158 in coupon below.



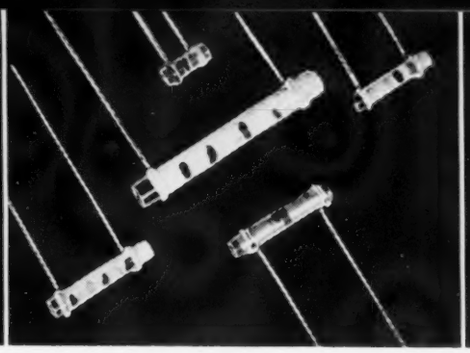
For miniature switches — specify Centralab's Series 20 with Steatite or Phenolic sections. Steatite is Grade L5. Meets JAN I-8 specs. Phenolic sections conform to JAN P-13 . . . Grade LTSE4. Available in 2 to 11 positions with stops, or 12 positions, continuous rotation—single or multiple sections—with or without attached on-off switch. Check No. 42-156.



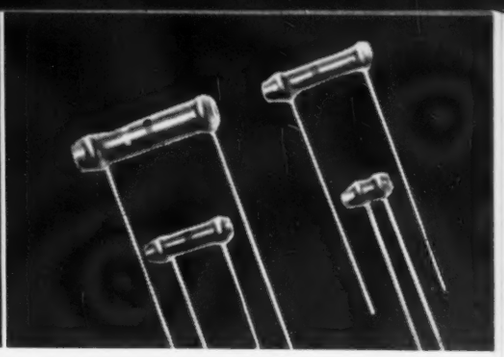
Centralab's Medium-Duty Power Switches. Use for R. F. or 110-115 V. application . . . 7½ amps. Voltage breakdown to ground — 3000 volts — RMS 60 cycles. Available with Grade L5 (JAN I-8) Steatite sections — shorting or non-shorting contacts. Models in 1, 2 or 3 poles, 18 contacts per section with adjustable stops, can be furnished up to 20 sections per shaft. Contacts and collector rings are coin silver. For complete data, check No. 42-136 in coupon.



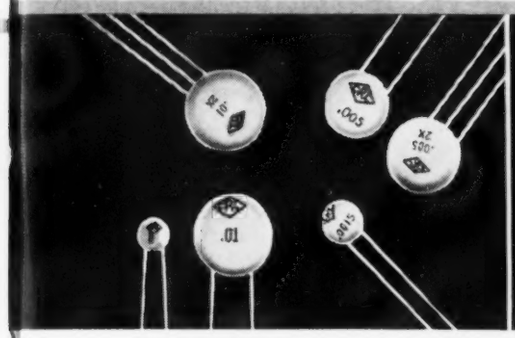
Centralab's Type 850 high voltage ceramic capacitors are especially designed for high voltage, high frequency circuits. Centralab's Type 950 high accuracy ceramic capacitors are especially developed for exacting electronic applications. Check bulletin No.'s 42-102 and 42-123.



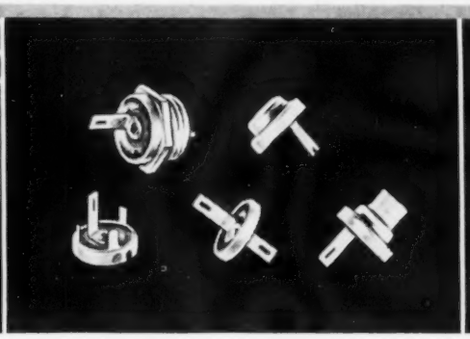
TC (Temperature Compensating) Tubulars — No prior contract approval or waiver necessary. Meet JAN-C-20A requirements. Type TCZ shows no capacitance change over wide range of temperature. Type TCN has special ceramic body to vary capacitance according to temperature. Bulletin No. 42-18.



BC (Bypass Coupling) Tubulars — Recommended for bypass coupling. Well suited to general circuit use. Centralab's own Ceramic X body provides imperviousness to moisture and low power factor. Easily withstands temperatures normally encountered in most electronic equipment. Bulletin No. 42-3.

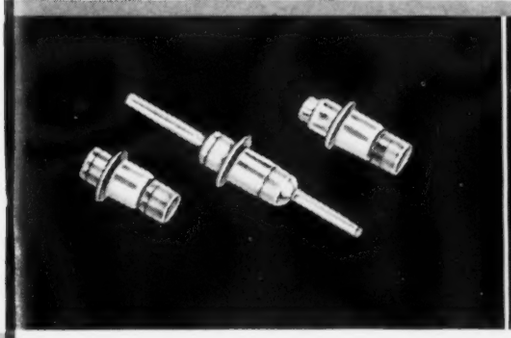


Ceramic Disc Hi-Kap Capacitors hold thickness to a minimum . . . have very high capacity in extremely small size. Use in h.f. circuits for bypass and coupling. Ceramic body assures low inductance. Other characteristics—humidity resistance, power factor, etc. — similar to BC Tubulars, Bulletin No. 42-4R.

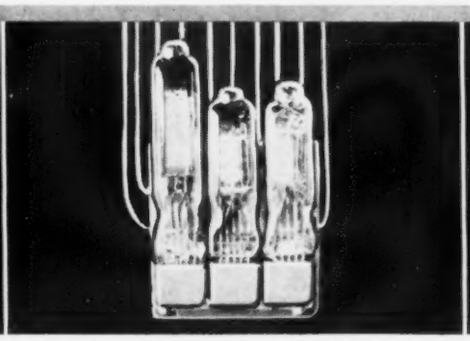


Something new in miniature ceramic capacitors! These "button types" are available in 5 different styles. Used for bypassing in low-power, high-frequency applications where small size, low inductance and light weight are essential. Check Bulletin No. 42-122 in coupon for more information.

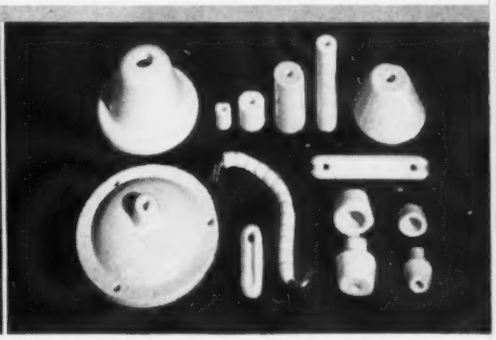
Centralab Ceramic Trimmers meet applicable portions of JAN-C-81. Very small size. Screw driver adjustment over full capacity range (180° rotation). Maintain stability in any position and under vibration. Spring pressure contact for rotor and stator. Bulletin No. 42-101.



Centralab's New Eyelet-Mounted Feed-Through Ceramic Capacitors are smallest available. They meet applicable portions of JAN-C-20A specifications. Capacities range from 10 to 3000 mmf . . . the widest range on the market. Voltage rating, 500 V.D.C.W. Check No. EP-15 in coupon.



New Sub-miniature Model III Ampec — a full three-stage speech amplifier of remarkably small dimensions — approximately $1\frac{1}{32}$" x $\frac{15}{16}$" x $\frac{11}{32}$" (barely larger than a postage stamp!). Excellent for microphone preamplifiers and similar applications. Check No. 42-130 on coupon for complete information.



Centralab standard and custom-molded Steatite ceramics plain or metallized . . . fully comply with JAN I-8. Steatite is Grade L5 for military use. Characteristics — high dielectric strength, low loss at high frequencies, high mechanical strength. For data on standard parts or custom molding, check No. 720.

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☐ 42-85 ☐ 42-158 ☐ 42-156 ☐ 42-136 ☐ 42-102 ☐ 42-123 ☐ 42-18
☐ 42-3 ☐ 42-4R ☐ 42-122 ☐ 42-101 ☐ EP-15 ☐ 42-130 ☐ 720

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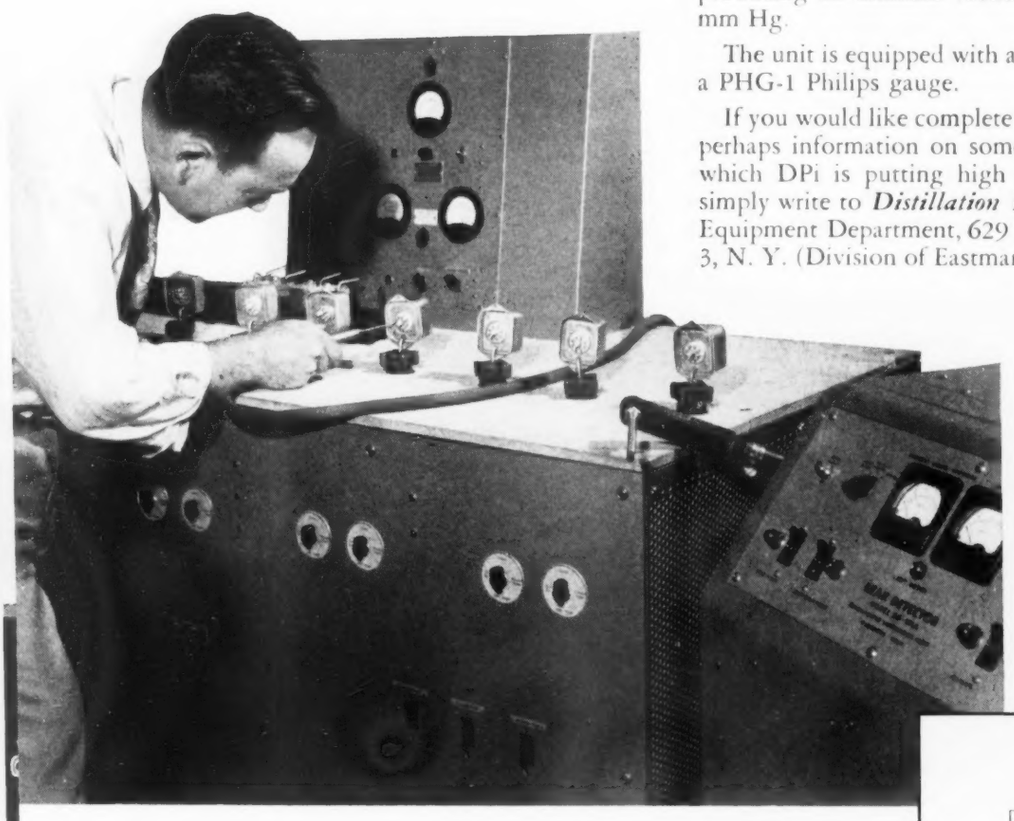
The Vacuum Manifold System is a completely contained "packaged unit," designed to operate from any 110-volt, 60-cycle line capable of handling 35 amperes.

Two mechanical pumps serve as the roughing and the backing pumps for the unit. The roughing pump evacuates the ports to a pressure within the operating range of the diffusion pump. The backing pump maintains a forepressure on the diffusion pump that is well below the required pressure for efficient diffusion pump operation. And three electrically energized solenoid valves on each port of the manifold permit continuous operation of the diffusion pump during the entire processing cycle.

This diffusion pump, DPi model MC-275, is capable of producing an ultimate vacuum of approximately 5×10^{-5} mm Hg.

The unit is equipped with a two station Pirani gauge and a PHG-1 Philips gauge.

If you would like complete technical data on this unit, or perhaps information on some of the many other ways in which DPi is putting high vacuum at industry's service, simply write to ***Distillation Products Industries,*** Vacuum Equipment Department, 629 Ridge Road West, Rochester 3, N. Y. (Division of Eastman Kodak Company).



DPi's 10-Port Vacuum Manifold System in use at Barber-Colman Company, Rockford, Illinois.

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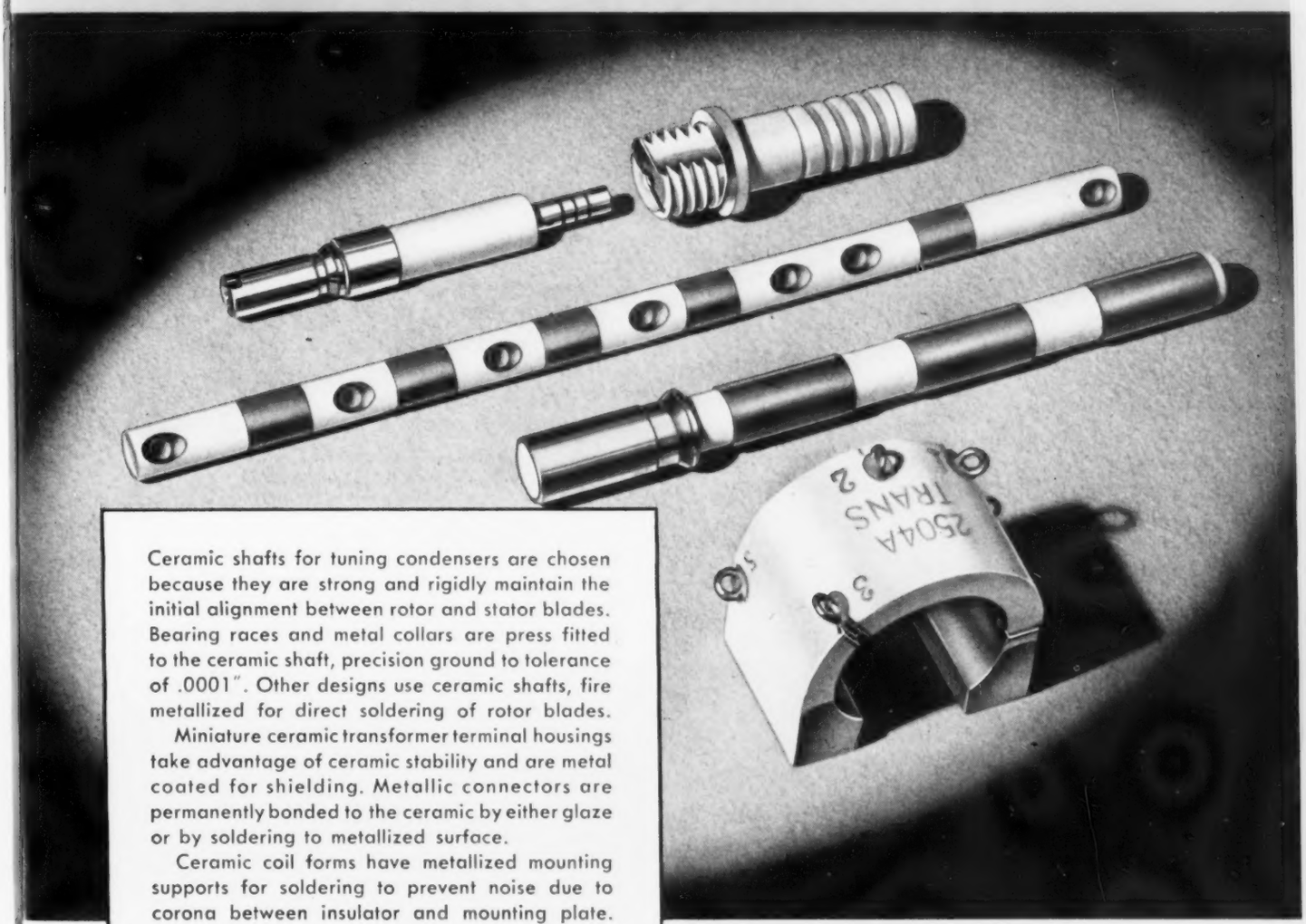

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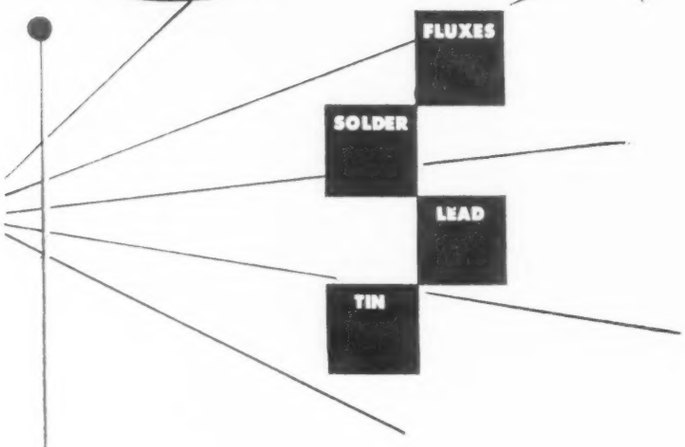

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Divco guarantees that all its rosin fluxes conform to all federal specifications for non-corrosive qualities

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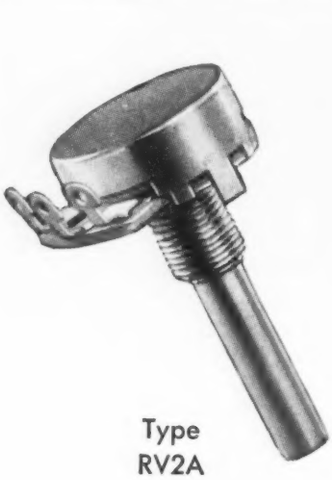

Type RV2A

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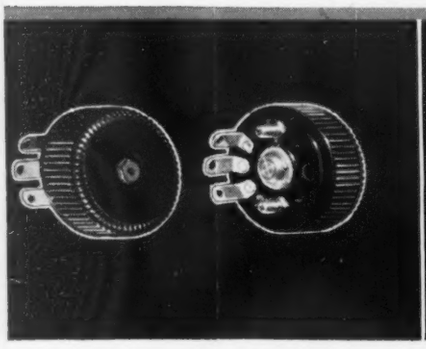

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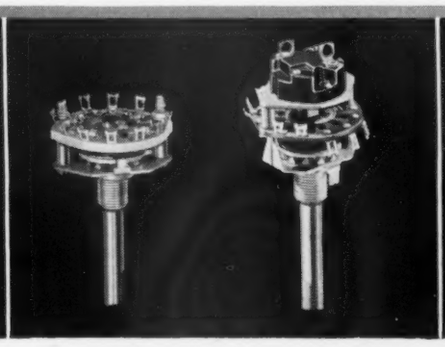

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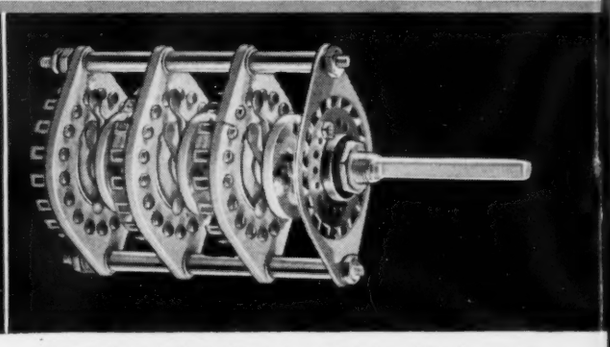

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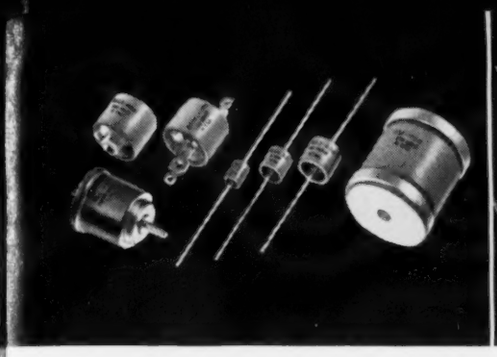
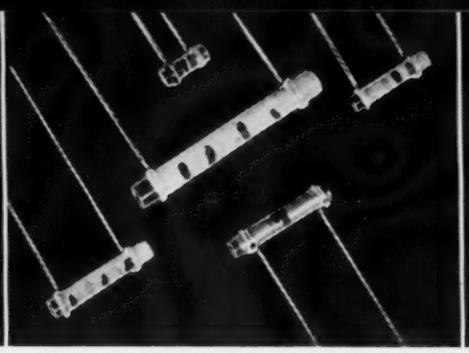
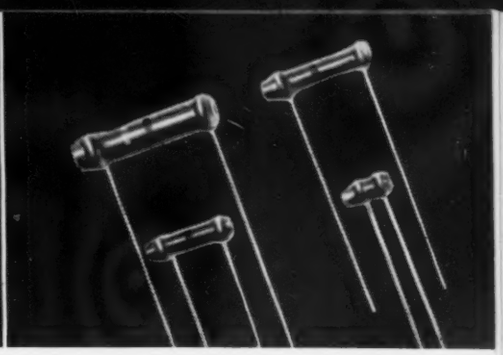


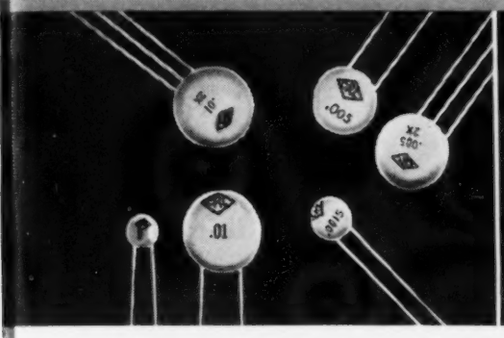
Centralab's Type 850 high voltage ceramic capacitors are especially designed for high voltage, high frequency circuits. Centralab's Type 950 high accuracy ceramic capacitors are especially developed for exacting electronic applications. Check bulletin No.'s 42-102 and 42-123.



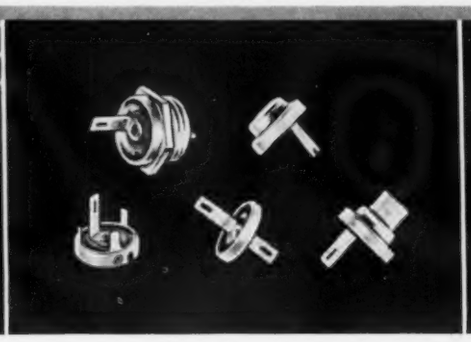
TC (Temperature Compensating) Tubulars — No prior contract approval or waiver necessary. Meet JAN-C-20A requirements. Type TCZ shows no capacitance change over wide range of temperature. Type TCN has special ceramic body to vary capacitance according to temperature. Bulletin No. 42-18.



BC (Bypass Coupling) Tubulars — Recommended for bypass coupling. Well suited to general circuit use. Centralab's own Ceramic X body provides imperviousness to moisture and low power factor. Easily withstands temperatures normally encountered in most electronic equipment. Bulletin No. 42-3.

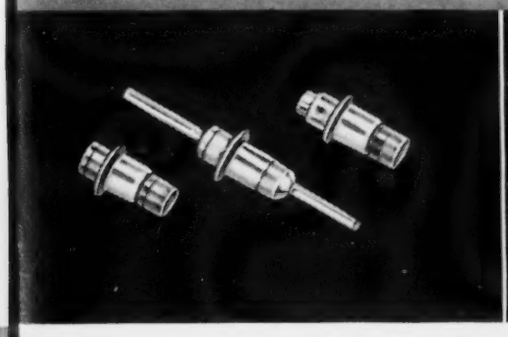


Ceramic Disc Hi-Kap Capacitors hold thickness to a minimum . . . have very high capacity in extremely small size. Use in h.f. circuits for bypass and coupling. Ceramic body assures low inductance. Other characteristics—humidity resistance, power factor, etc. — similar to BC Tubulars, Bulletin No. 42-4R.

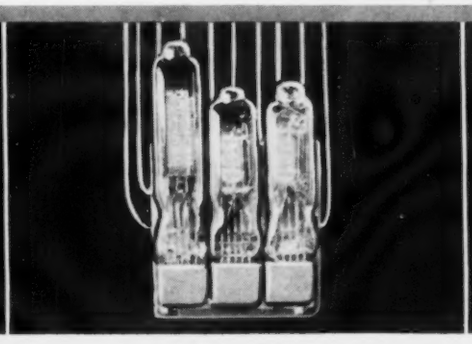


Something new in miniature ceramic capacitors! These "button types" are available in 5 different styles. Used for bypassing in low-power, high-frequency applications where small size, low inductance and light weight are essential. Check Bulletin No. 42-122 in coupon for more information.

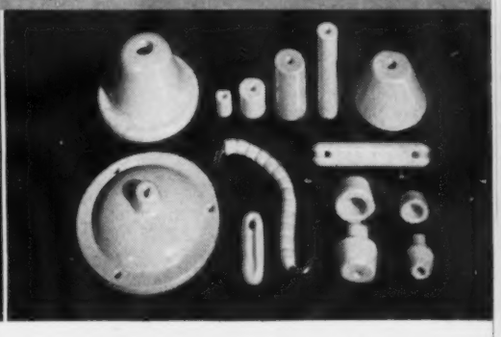
Centralab Ceramic Trimmers meet applicable portions of JAN-C-81. Very small size. Screw driver adjustment over full capacity range (180° rotation). Maintain stability in any position and under vibration. Spring pressure contact for rotor and stator. Bulletin No. 42-101.



Centralab's New Eyelet-Mounted Feed-Through Ceramic Capacitors are smallest available. They meet applicable portions of JAN-C-20A specifications. Capacities range from 10 to 3000 mmf...the widest range on the market. Voltage rating. 500 V.D.C.W. Check No. EP-15 in coupon.



New Sub-miniature Model III Ampec — a full three-stage speech amplifier of remarkably small dimensions — approximately $1\frac{1}{32}$" x $\frac{15}{16}$" x $1\frac{1}{32}$" (barely larger than a postage stamp!). Excellent for microphone preamplifiers and similar applications. Check No. 42-130 on coupon for complete information.



Centralab standard and custom-molded Steatite ceramics plain or metallized . . . fully comply with JAN I-8. Steatite is Grade L5 for military use. Characteristics — high dielectric strength, low loss at high frequencies, high mechanical strength. For data on standard parts or custom molding, check No. 720.

Centralab

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T

Please send me Technical Bulletins as marked

☐ 42-85 ☐ 42-158 ☐ 42-156 ☐ 42-136 ☐ 42-102 ☐ 42-123 ☐ 42-18
☐ 42-3 ☐ 42-4R ☐ 42-122 ☐ 42-101 ☐ EP-15 ☐ 42-130 ☐ 720

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High Vacuum "Packaged System"

for leak detecting, gas filling, sealing

● DPi's 10-PORT VACUUM MANIFOLD SYSTEM is greatly improving the efficiency of processing sealed relays, small containers, and delicate mechanisms in the electronics industries.

Used specifically for leak detecting, gas filling, and sealing, it is particularly effective in checking units for microscopically small leaks. (A Consolidated Leak Detector, which is connected to the system, can sound an alarm for a leak so small that a thimbleful of air would take 30 years to get through.)

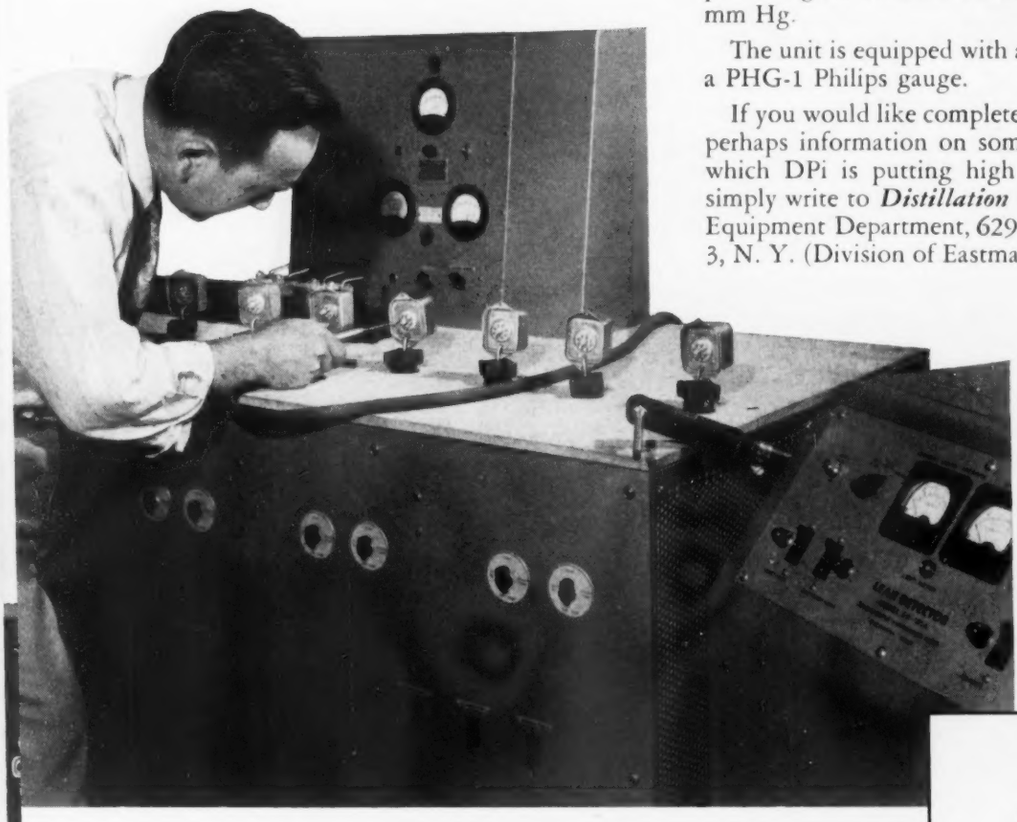
The Vacuum Manifold System is a completely contained "packaged unit," designed to operate from any 110-volt, 60-cycle line capable of handling 35 amperes.

Two mechanical pumps serve as the roughing and the backing pumps for the unit. The roughing pump evacuates the ports to a pressure within the operating range of the diffusion pump. The backing pump maintains a forepressure on the diffusion pump that is well below the required pressure for efficient diffusion pump operation. And three electrically energized solenoid valves on each port of the manifold permit continuous operation of the diffusion pump during the entire processing cycle.

This diffusion pump, DPi model MC-275, is capable of producing an ultimate vacuum of approximately 5×10^{-5} mm Hg.

The unit is equipped with a two station Pirani gauge and a PHG-1 Philips gauge.

If you would like complete technical data on this unit, or perhaps information on some of the many other ways in which DPi is putting high vacuum at industry's service, simply write to ***Distillation Products Industries,*** Vacuum Equipment Department, 629 Ridge Road West, Rochester 3, N. Y. (Division of Eastman Kodak Company).



DPi's 10-Port Vacuum Manifold System in use at Barber-Colman Company, Rockford, Illinois.

high vacuum research and engineering

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Spotlights ALSIMAG®

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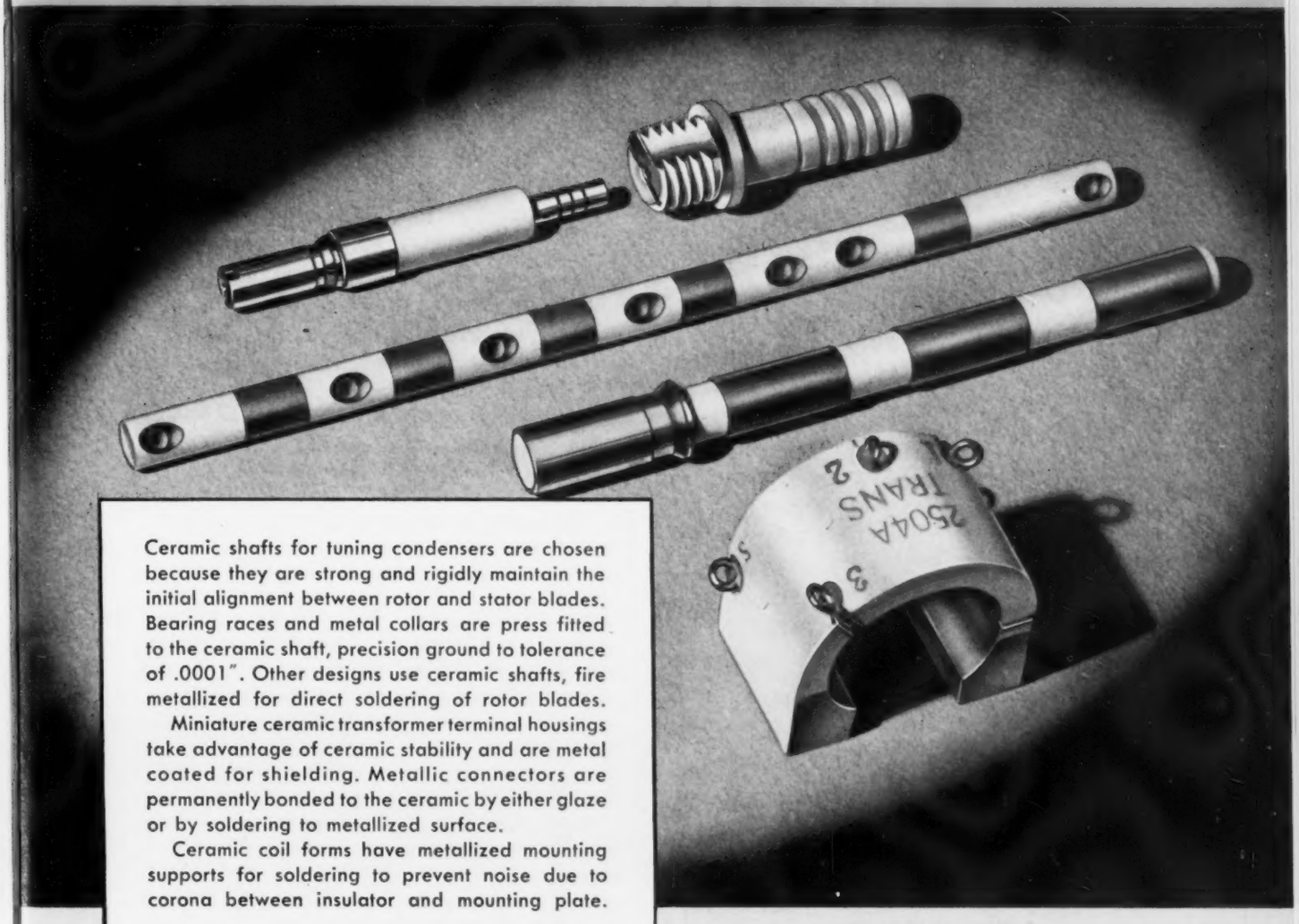

Ceramic shafts for tuning condensers are chosen because they are strong and rigidly maintain the initial alignment between rotor and stator blades. Bearing races and metal collars are press fitted to the ceramic shaft, precision ground to tolerance of .0001". Other designs use ceramic shafts, fire metallized for direct soldering of rotor blades.

Miniature ceramic transformer terminal housings take advantage of ceramic stability and are metal coated for shielding. Metallic connectors are permanently bonded to the ceramic by either glaze or by soldering to metallized surface.

Ceramic coil forms have metallized mounting supports for soldering to prevent noise due to corona between insulator and mounting plate.

Our broad experience in metal-ceramic combinations is available to you on request.

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KOVAR-GLASS TERMINALS
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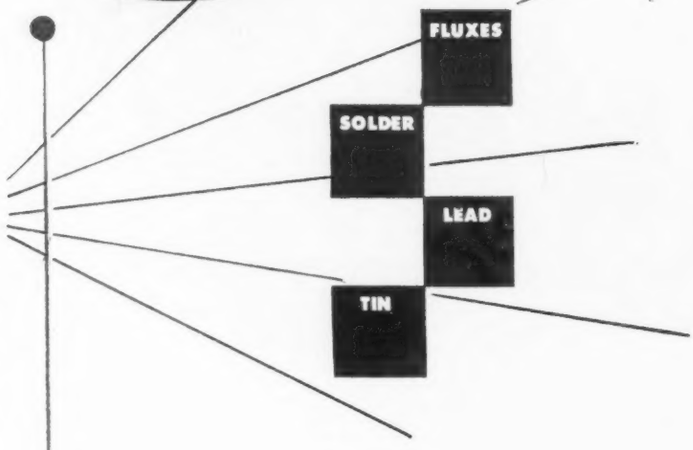

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ACID CORE	RIBBON
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DROP	SHEET
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ANOTHER DIVCO EXCLUSIVE— HOMOGENIZED ROSIN FLUXES

Rosin and any solvent combined by the Divco process produce an homogenized rosin flux which:

- will not precipitate, settle, or crystallize while in use or storage
- confines evaporation to an absolute minimum, guaranteeing a saving of at least 25% in evaporation as compared to any other rosin flux
- can be restored to its original consistency regardless of evaporation
- gives maximum resistance to corrosion
- possesses high dielectric strength

Divco guarantees that all its rosin fluxes conform to all federal specifications for non-corrosive qualities

DIVCO ROSIN FLUX REMOVER

- non-toxic
- fire-resistant
- removes residues efficiently
- prevents waste of solvent
- save time and labor

ultra violet (black light) inspection proves that Divco Rosin Flux Remover leaves no trace of residue.

Divco Soldering Flux Test Kit

At a very nominal cost, your laboratory or engineering department can solve and determine the answer to any soldering or soldering flux problem. The Divco Soldering Flux Test Kit contains one-ounce test bottles of the complete line of Divco Soldering Fluxes, and of Divco rosin and acid residue flux removers.

Divco imagineering doesn't stop with the products listed above. It begins with your needs, your wants—and ends with their satisfaction.

Divco engineering and technical service is available without cost.

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DIVCO X-25 "X 25 - BETTER SOLDERING"

ROSIN CORE SOLDER

DIVCO'S X-25 ROSIN CORE SOLDER is named after the X-factor in it . . . a new, totally different flux ingredient. This X-factor means extra fast and better soldering because it provides flux activity at a temperature even before the solder is completely molten. Result: solder takes to the base metal *immediately* . . . NO COLD JOINTS, instead, a stronger, surer bond achieved at a lower temperature in less time! Satisfaction is further amplified by its non-corrosiveness and high dielectric properties equal to pure rosin flux.

Divco X-25 is available now, in any size or quantity.

Please write for prices and further information.

DIVCO guarantees that X-25 ROSIN CORE SOLDER conforms to all armed forces and federal specifications for non-corrosive qualities and solder analysis.

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TELE-TIPS

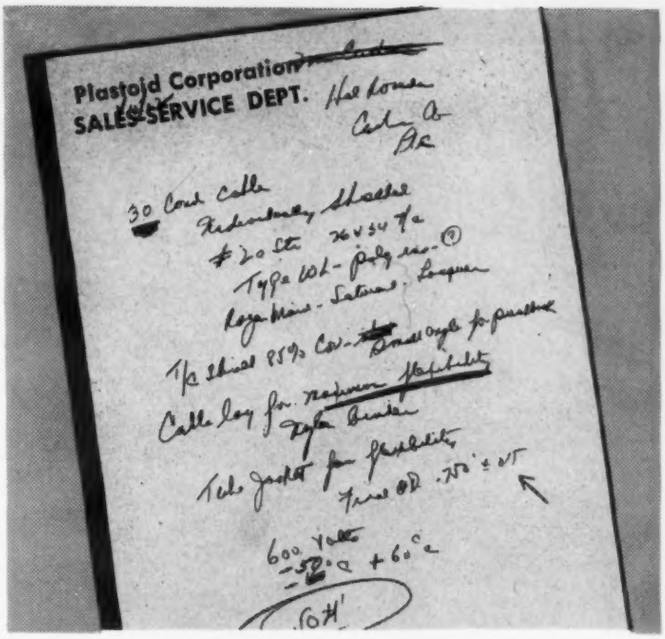
AUDIENCE-TV—A new use for television—that of providing an unhindered view of central stage proceedings to large audiences—was unveiled by the General Electric Company during its 60th annual share-owners meeting. Easter hats, impressive hairdos and large pillars failed to block the view of the record-breaking audience of more than 2,200 in the 30,000-square feet meeting hall. Eight 24-inch G-E television receivers hanging from slings throughout the hall transmitted the proceedings on a closed circuit. No attending share owner was thus ever more than 60 feet from the actual proceedings through the eyes of television.

TV RAIN—Creating the illusion of rain without using water is a new development in the CBS-TV special effects department. The trick is done by the reflections of a floodlight shining upon a spinning emery wheel. The reflected images, resembling raindrops, are superimposed on the play's scene of action. Proper sound effects are introduced and actors wear raincoats to complete the illusion.

TRANSISTORS will be made by Transistor Products, Inc., Rahway, N. J., a new subsidiary of Purolator Products, Inc., of which R. R. Layte is president. A license has been obtained from Western Electric, and Scientific Specialties Co., Boston, will produce special equipment for quantity transistor manufacture. Roland B. Holt, formerly of Harvard, will head the technical staff of the new company which also will engage in research.

ITALIAN radio listeners are compelled to take out licenses to use their radio receivers. However, there is a sugar coating to this particular pill, since everyday after January 20 of each year one license number is drawn by lot. The winner receives a prize such as a car, motorcycle, refrigerator, watch, sewing machine, stove, etc. If listeners in this country were licensed on the basis of receivers in use the odds would be about 110,000,000 to 1!

(*Continued on page* 24)



An instruction sheet recently received from a valued customer. The company knew the properties it wanted . . . and left it to Plastoid to work out the details.

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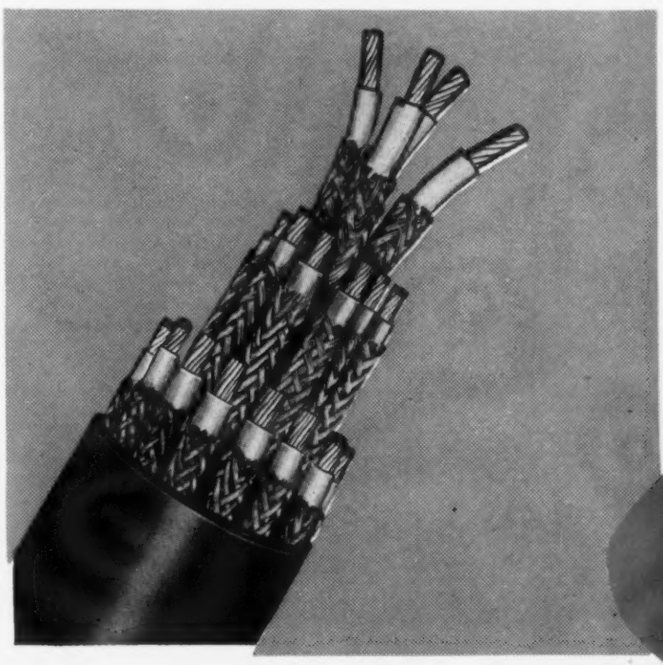
—WE KNOW HOW!

Here, in two simple photographs, is a perfect illustration of Plastoid's service to the electronic industry.

For *your* wire or cable needs, get in touch with Plastoid. In addition to supplying all standard constructions, our excellent staff of engineers and production men will gladly cooperate with you in designing — and producing — cable *to fit your requirements.*



The finished job . . . a custom-engineered SYNKOTE ¾" cable with 30 individually-shielded conductors, fungus-resistant, flexible, designed to "take it" at −50°C or +60°C!

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Multi-Conductor Cables

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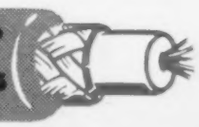
NYLON JACKETING • HIGH TEMPERATURE WIRE • MULTI-CONDUCTOR CABLES



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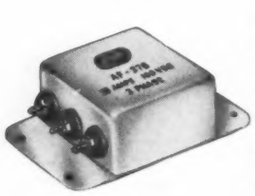
METALITE* Metallized Paper Capacitors. Ultra-compact, self-healing, light weight Astron METALITE metallized paper capacitors offer the ultimate in capacitor miniaturization and dependability. Ideal for military applications, they are available in a variety of standard and special designs.

Subminiature Paper Capacitors For 125°C. Operation *WITHOUT DERATING.* Astron type AQ subminiature paper capacitors, specifically designed for operation through 125°C. without derating, offer exceptional capacitance stability as well as other desired electrical characteristics over the entire temperature range. Ideally suited for military applications, they are extensively used in government equipment where high temperature and space limitations are a factor.

Dry Electrolytic Capacitors. Manufactured to exceed the most rigid quality specifications, Astron dry electrolytic capacitors are extremely compact, stable, and include the latest developments in electrolytic capacitor design. Preferred by leading television and electronic manufacturers, they are available in a wide variety of container styles and mountings.

Molded Paper Tubulars. Astron molded paper tubular capacitors are designed for dependable operation under the most adverse field conditions. Perfectly sealed against humidity, they are molded in a high temperature heat resistant plastic compound prior to impregnation.

Oil Filled Capacitors. Mineral oil filled and impregnated, Astron oil filled capacitors are hermetically sealed and supplied in a variety of government specified case styles. Designed for outstanding performance under the most severe operating conditions, Astron oil filled capacitors meet the most rigid military specifications.



RF Interference Filters. Light in weight, small in size, Astron noise suppression filters are currently serving with distinction throughout the aviation and electronics industries. Astron's filter specialists are equipped to recommend or design special filters for every electrical and physical requirement.

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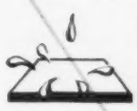
Teflon may be used continuously at 200°C. (392°F.); or for short periods at 250°C. (482°F.). Meets A.I.E.E. Standards for Class H electrical insulation.



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Teflon products have practically zero water absorption and are unaffected by fungus, humidity and temperature changes. It remains pliable at −87.5°C. (−100°F.).

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Teflon will not carbonize, but rather will vaporize. When the arc is extinguished, full insulation is restored.

CHEMICAL RESISTANT

Teflon is the most inert of all commercial thermoplastics and is not affected by any known solvent.

THAT'S WHY C-D-F TEFLON TAPES AND SHEETS CAN OFFER THESE BIG ADVANTAGES

FOR LINING SLOTS C-D-F sheets of fibre glass cloth supported Teflon can be cold-formed into easily loaded slot liners. Teflon is naturally slippery smooth, with plenty of "snap back." High in dielectric strength, liners are rated Class H insulation.

FOR WRAPPING CABLES C-D-F Teflon tapes are tough, strong, and stretchable. Teflon can be supplied unsupported, or combined with fibre glass fabrics in a variety of widths and thicknesses. It is suitable for winding around sharp bends or odd shapes.

FOR CHEMICAL AND MECHANICAL USES Remember, Teflon is non-adhesive and chemically inert. Bakers, food packagers, and pump manufacturers use it. For applications requiring extreme electrical insulation stability, high temperature or resistance to corrosion, C-D-F unsupported and fibre glass cloth supported products can do a job for you.

C-D-F's work with Teflon is really rolling! New applications are being developed daily in our laboratories by specialists who are devoting their entire time to improving and developing new Teflon products. Start talking Teflon with the man from C-D-F (sales offices in principal cities)—he's a good man to know!

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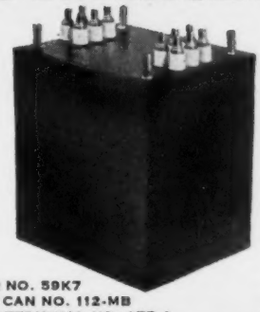
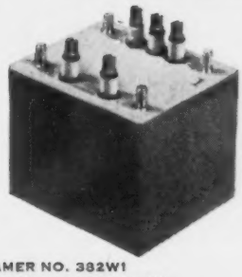
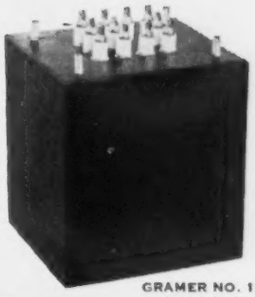


GRAMER NO. 59K7
HELDOR CAN NO. 112-MB
HELDOR TERMINAL NO. 375-A

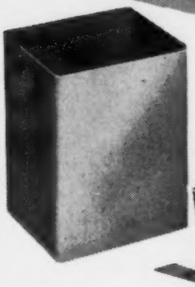


GRAMER NO. 382W1
HELDOR CAN NO. 130-YY
HELDOR TERMINAL NO. 250-A



GRAMER NO. 113K88
HELDOR CAN NO. 107-HA
HELDOR TERMINAL NO. 375-A

...manufactured with



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built to meet

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Heldor Transformer Cans and Terminals were chosen by Gramer Transformer Corporation as ideal components for their products. They know that from design through production, every operation, every part is completed to meet MIL-T-27 Specifications.

Whether your product must meet a MIL-T-27 specification or not, Heldor Transformer Cans, Compression Type Hermetic Seal Bushing Assemblies and completely assembled units can save you money, time and worry.

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Please send me prices and specifications on MIL-T-27 cans and bushings.

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Company .....

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COMPACT, INTEGRATED DESIGN THAT SAVES VALUABLE FLOOR SPACE

There's a *BIG ECONOMY* story behind this fabulous new line of TV TRANSMITTERS

It's an amazing story of advanced design features that save TV Broadcasting dollars—your dollars—both at the start and over the many years that follow. It's a down-to-earth, brass tack story of tangible improvements in circuitry, mechanical design, low cost tube complements, low power consumption and dozens of other things that add up to smoother, more efficient operation at an unbelievably low cost.

Get all the *TIME-AND-MONEY-SAVING* facts today!

Whether you have TV Transmitter equipment already on order or not—it will pay you handsomely to get the new S-E 12 page Catalog. Use it as a yardstick of comparison before you order or install competitive equipment. After you see it, we know you'll agree that S-E Transmitters offer more advanced design features, more operating conveniences, lower tube and operating costs than any other make, regardless of price.

CALL, WIRE OR WRITE FOR IMMEDIATE INFORMATION!

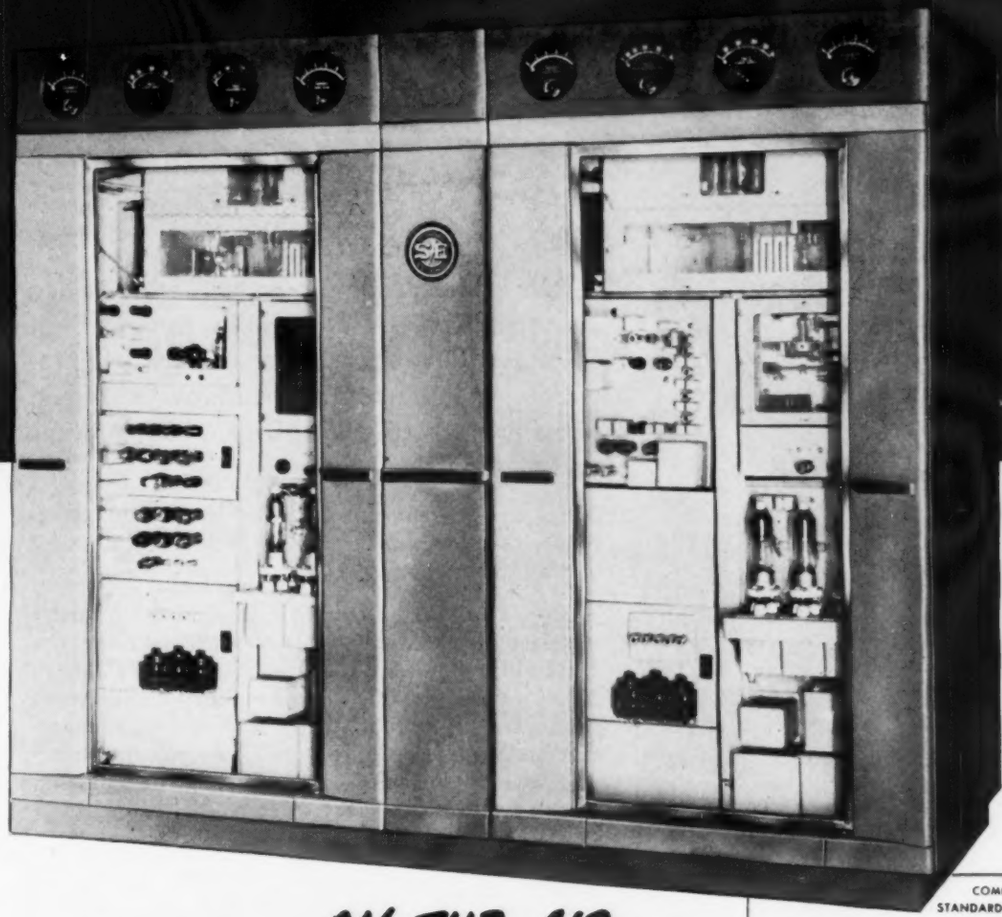
"A CLAUDE NEON, INC. PRODUCT"

STANDARD ELECTRONICS

285-295 EMMETT STREET, NEWARK 5, NEW JERSEY

IN TV IS S-E!

TV TRANSMITTER HISTORY!



COMPARE THEM ALL

-regardless of price!

Check these equipments, feature by feature, with any other on the market today . . . at any price. From every standpoint — economic, technical or operational — you'll find none more advanced in design, more economical to buy and operate, and none more outstanding in performance than these great new S-E TV Transmitters.

You can get *ON-THE-AIR* fast

with the S-E MINIMUM-STATION PACKAGE . . . it's expandable up to 20 KW at any time at low cost! This package —one of the best "buys" in TV today—puts you on the air for revenue-producing operation in the shortest possible time. It is a complete operating station including a 500 watt transmitter, high gain antenna, and essential film and slide pickup equipment. The S-E Minimum Station Package is very low in initial cost, operating cost and upkeep. Details on request.

COMPARATIVE ADVANTAGES OF THE NEW STANDARD TV TRANSMITTER BASED ON 5 KW OUTPUT

SPECIFICATIONS	Standard Electronics	Competitive Transmitters A	B	C	D
Approx. cost – 1 Set of tubes	$1400	$1500	$1600	$1700	$3000
Approx. power consump. (aver. pic.)	15KW	18KW	25KW	23KW	25KW
Similarity of tube line-up, aural and visual	YES	NO	NO	YES	NO
Physical length	178 in.*	180 in.	199 in.	215 in.	208 in.
Self-contained, both bands	YES	NO	NO	NO	NO
Air cooled, both bands	YES	YES	YES	YES	NO
Factory adjusted side band filter	YES	NO	YES	NO	YES
Ability to use driver as stand by transmitter	YES	NO	NO	NO	NO

*Includes side band filter

Distributed by Graybar Electric Company

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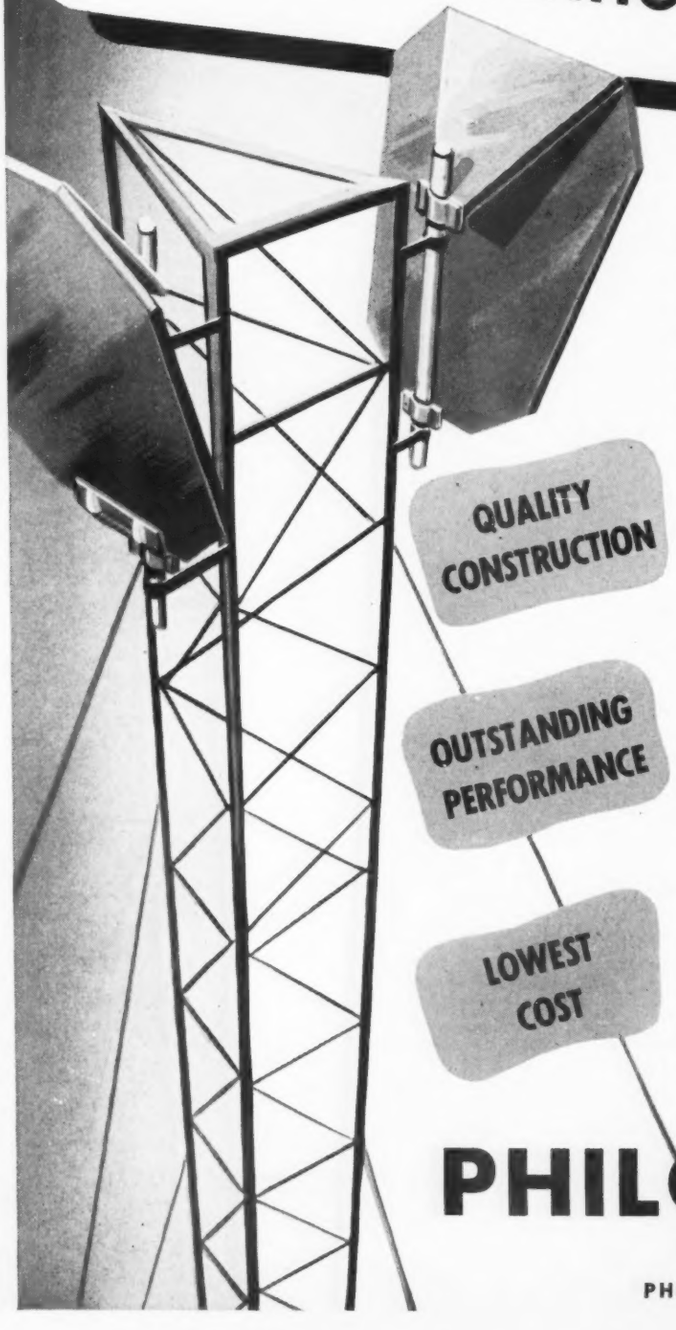
DON'T SETTLE FOR LESS!

PHILCO

Advanced Design MICROWAVE COMMUNICATIONS SYSTEMS



QUALITY CONSTRUCTION

OUTSTANDING PERFORMANCE

LOWEST COST

Again Philco leads the way . . . with Philco *Advanced Design* Microwave Communications Systems. Philco's years of experience in microwave development has produced a system unsurpassed in reliability, performance and economy.

All components are of the finest quality, conservatively rated, insuring long life and economical operation and maintenance.

A signal level 1000 times greater than normally required insures dependable service even under the most adverse conditions. Philco *Advanced Design* Microwave is flexible. The broadband microwave channel may be divided to carry up to 24 simultaneous 2-way telephone conversations . . . or be further divided for telegraph, teletype, telemetering, signaling or supervisory circuits.

Years of production experience enable Philco to produce microwave systems for the lowest possible cost consistent with highest quality. Future expansion can be easily accomplished with no loss of original investment.

For dependable communications service 24 hours a day, every day of the year . . . *don't settle for less* than Philco *Advanced Design* Microwave Communications Systems!

PHILCO CORPORATION

INDUSTRIAL DIVISION

PHILADELPHIA 34, PENNSYLVANIA

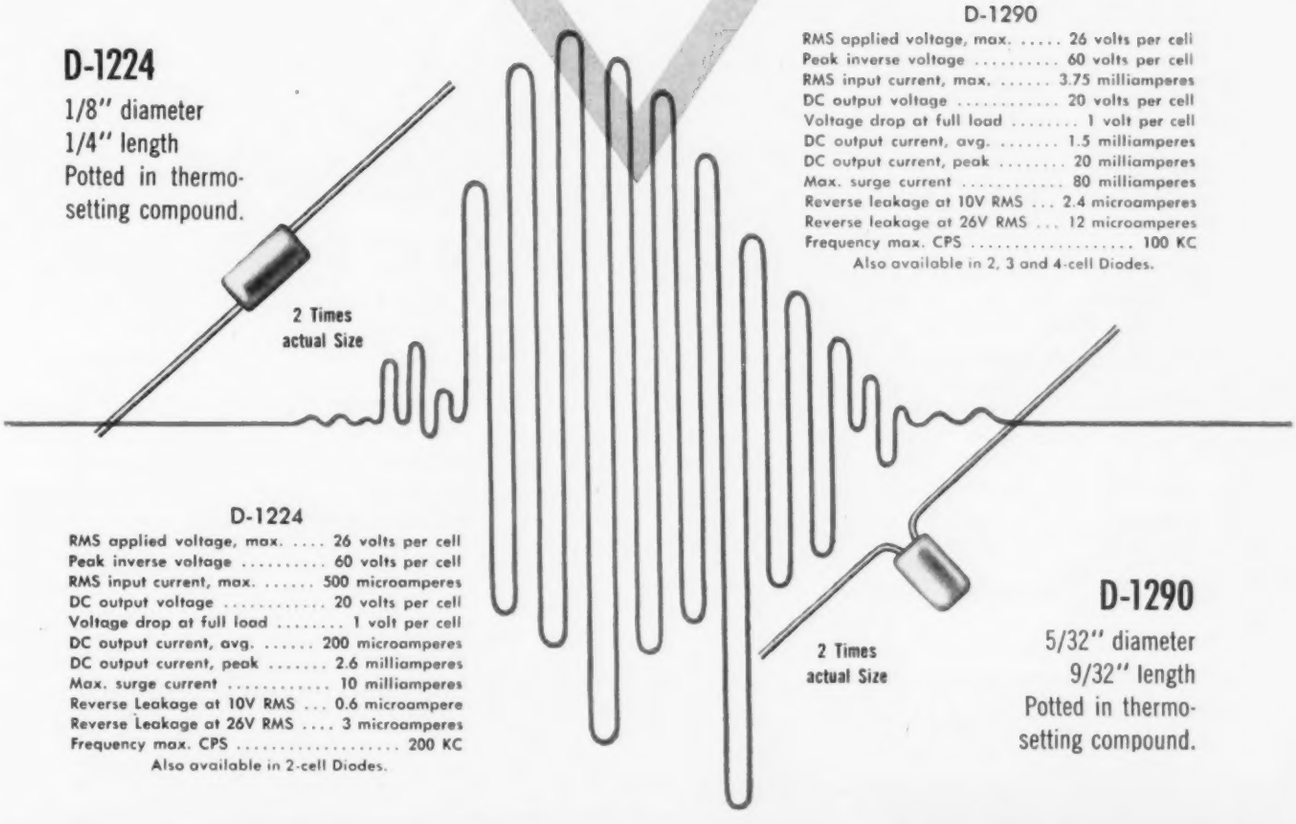
International
RECTIFIER
CORPORATION

EL SEGUNDO
CALIFORNIA

Selenium Diodes

D-1224

1/8" diameter
1/4" length
Potted in thermo-setting compound.



D-1224

RMS applied voltage, max.	26 volts per cell
Peak inverse voltage	60 volts per cell
RMS input current, max.	500 microamperes
DC output voltage	20 volts per cell
Voltage drop at full load	1 volt per cell
DC output current, avg.	200 microamperes
DC output current, peak	2.6 milliamperes
Max. surge current	10 milliamperes
Reverse Leakage at 10V RMS	0.6 microampere
Reverse Leakage at 26V RMS	3 microamperes
Frequency max. CPS	200 KC

Also available in 2-cell Diodes.

D-1290

RMS applied voltage, max.	26 volts per cell
Peak inverse voltage	60 volts per cell
RMS input current, max.	3.75 milliamperes
DC output voltage	20 volts per cell
Voltage drop at full load	1 volt per cell
DC output current, avg.	1.5 milliamperes
DC output current, peak	20 milliamperes
Max. surge current	80 milliamperes
Reverse leakage at 10V RMS	2.4 microamperes
Reverse leakage at 26V RMS	12 microamperes
Frequency max. CPS	100 KC

Also available in 2, 3 and 4-cell Diodes.

D-1290

5/32" diameter
9/32" length
Potted in thermo-setting compound.

International
RECTIFIER CORPORATION

GENERAL OFFICES:
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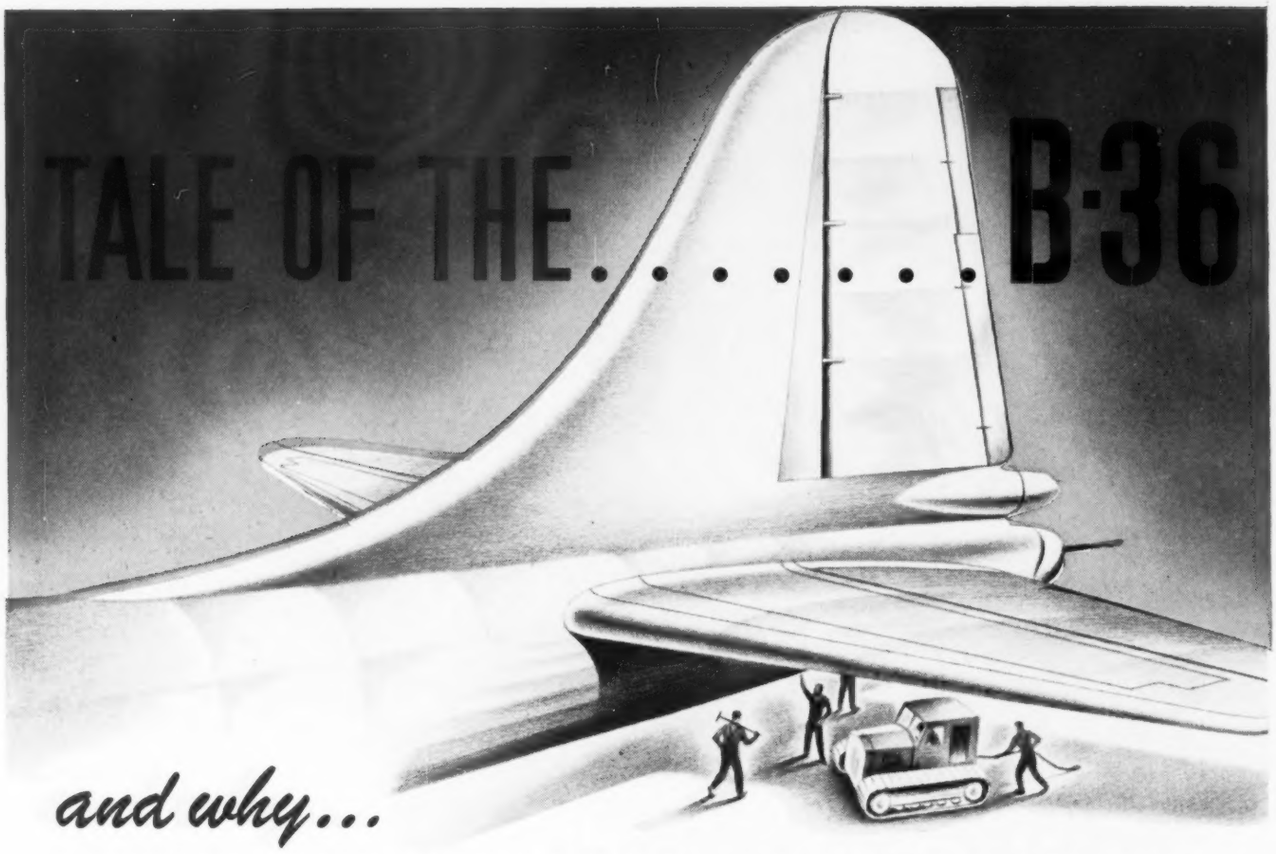
El Segundo, Calif.
Phone El Segundo 1890

CHICAGO BRANCH OFFICE:
205 W. Wacker Dr.
Franklin 2-3889



and why...

ROBINSON ENGINEERED MOUNTING SYSTEMS ARE SPECIFIED

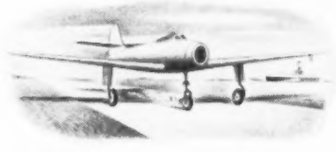
The B-36 is a fabulous airplane and a mighty weapon. Its piston engines alone pack a total of 21,000 horsepower. It takes an hour to warm them up. The surging slip stream, during this long run-up, causes extremely heavy vibration and oscillation of the aft section and tail of the airplane.

The extensive electronic equipment installed here was at first inadequately protected by "stock type" shock mounts. The equipment was shaken and pounded. Tube life dropped from several hundred hours to less than 10. Equipment failure was common, sometimes seriously affecting the success of the mission.

That is why you will now find 25 Robinson Engineering Mounting Systems aboard the B-36. They are designed to meet the specific conditions of vibration, oscillation, weight and center of gravity under which the equipment must operate in order to insure the successful completion of the assigned mission.

Robinson Systems assure extended service life from vital electronic components. Their "plus" features provide protection beyond present military specifications and a wide margin of reserve for the extra loads of combat maneuvers. Robinson systems are all-metal —unaffected by temperature, altitude, or age.

IN TODAY'S AIRCRAFT—ROBINSON MET-L-FLEX MOUNTS



Terrific runway speeds often produce shock loads above 8 "G's" in today's high performance aircraft. These planes *must* depend on mounting bases capable of delivering the high damping and overload protection needed to keep their vital electronic equipment in operating condition.

Instrument panels in assault transports operating from unimproved forward fields must be protected from vibration and shock. Robinson MET-L-FLEX cup type and multi-directional mounts support and cushion these panels — permitting accurate instrument readings while on the ground or in the air.

Helicopters pose many special problems of design and mounting peculiar to this type of aircraft. Conventional mounts are usually ineffective. Robinson was among the first to create successful new type all-metal mounting systems specifically for helicopter use.

There's a Robinson Engineering Representative near you. Let him show you the "plus" features that are exclusively Robinson's. Call or write today.

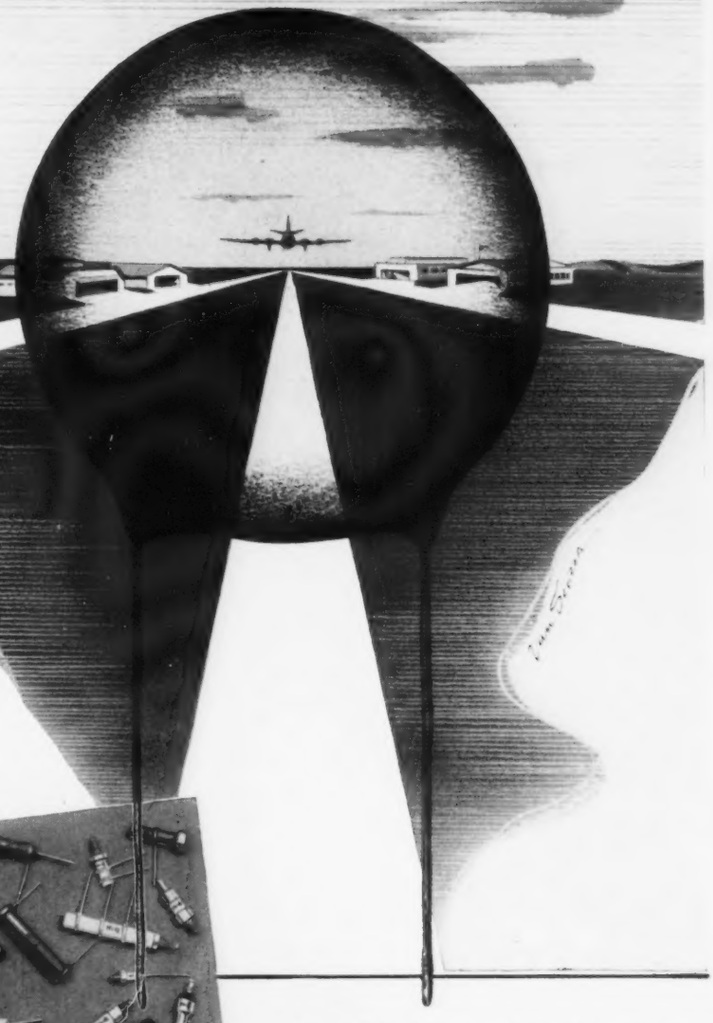
ROBINSON AVIATION INC.

TETERBORO, NEW JERSEY

Vibration Control Engineers

HI-Q* SERVES NATIONAL DEFENSE

Wherever Electronics [illegible] Home



The amazing and intricate science of electronics has provided new eyes and ears to bring our airmen straight home from anywhere . . . to sight a target many horizons beyond the span of human vision. On land and sea, electronics likewise has become a vital keystone in national defense. And wherever you find electronics, you'll find **HI-Q** . . . Small Ceramic Disk Capacitors, for example, of both the by-pass and temperature compensating types. Tubulars, perhaps . . . Plate or the new High Voltage units. And wherever you find **HI-Q** you'll find unfailing dependability, rigid adherence to specifications and tolerances, and long life. Whether your needs are for standard or specially designed components, **HI-Q** engineering and production keenness can meet your most exacting requirements.

Specializing in ceramic capacitors, **HI-Q** has developed a complete line of Temperature Compensating Disk Capacitors with a capacity range from 475 mmf to .3 mmf and standard tolerances of ±5%, 10% or 20%. For applications requiring a large gradient of capacity vs. temperature **HI-Q** Extended Temperature Compensating Disk Capacitors are available. These together with **HI-Q** By-pass Disk Capacitors give you one source of supply for all ceramic Disk type capacitors. Write for New Engineering Bulletin on Disks.

HI-Q* DIVISION

AEROVOX CORPORATION

OLEAN, NEW YORK, U. S. A.

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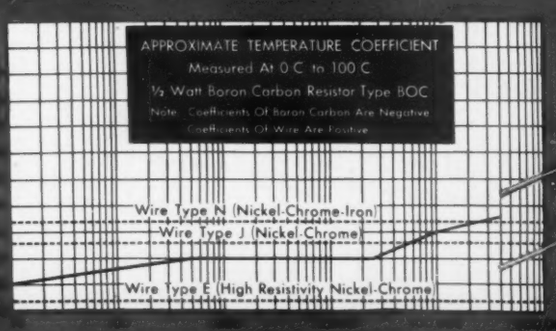
Ingenuity is *in resistors too!*

New Materials — New Techniques — New Advantages
Features in 4 New IRC Resistors

1 IRC Type BOC Boron-Carbon ½-Watt PRECISTOR Meets All Requirements of MIL-R-10509 Specification

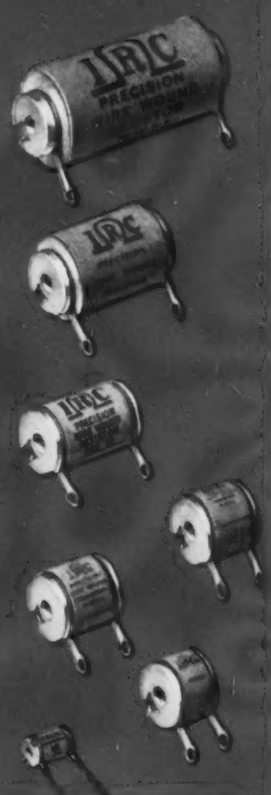
No other non-wire-wound resistor combines the advantages of this all-new Boron-Carbon unit. Type BOC reduces the temperature coefficient of conventional deposited carbon resistors—provides high accuracy *and* long-time stability—replaces high value wire wound precisions at savings in space and cost. You'll find it adaptable to a host of critical circuitry needs—in electronics and avionics, communications, telemetering, computing and service instruments. Send for full details in Catalog Data Bulletin B-6.


APPROXIMATE TEMPERATURE COEFFICIENT
Measured At 0°C to 100°C
½ Watt Boron Carbon Resistor Type BOC
Note: Coefficients Of Boron Carbon Are Negative
Coefficients Of Wire Are Positive
Wire Type N (Nickel-Chrome-Iron)
Wire Type J (Nickel-Chrome)
Wire Type E (High Resistivity Nickel-Chrome)

Type BOC conforms to all requirements of MIL-R-10509. Exposed to a temperature of 65°C. for one hour, the new BOC shows a resistance change of less than .2%. High temperature operation with reliability is now possible. Voltage coefficient is less than 20 parts per million per volt. Load life is outstanding; on a 500-hour test at ambient temperature of 40°C., resistance change will not exceed 2%.

essential

4 New IRC Type WW Precision Wire Wounds Surpass JAN-R-93 Characteristic B Specifications

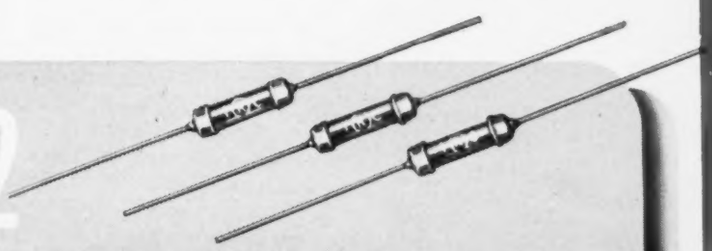


Here is the most reliable and stable of all wire-wound precisions... by unbiased test! Actually, new Type WW's far surpass JAN-R-93 Characteristic B Specifications. *New winding forms* hold more wire for higher resistance values. *New winding technique* and rigid insulation tests eliminate possibility of shorted turns or winding strains. *New type insulation* withstands humidity, assures long life, provides stability and freedom from noise. *New terminations* (except in small size WW-10) are rugged lug terminals for solder connection. Full data in Catalog Bulletin D-3.

	Original Resist.	1st Cycle % Chge	2nd Cycle % Chge	3rd Cycle % Chge	4th Cycle % Chge	Resist. at End of 100 hrs. load	Total % Chge	% Chge from Last Temp. Cycle to End of 100 hrs. load %	Resistance Chge at End of 100 Hrs. Load only % (no cycling)	
1	100,010	+ 04	+ 04	+ 05	+ 05	100,050	+ 04	— 01	100,040	— 02
2	100,000	+ 03	+ 04	+ 03	+ 05	100,060	+ 06	+ 01	100,000	0
3	100,000	+ 01	+ 02	+ 02	+ 05	100,000	0	+ 05	100,050	— 02
4	100,000	+ 02	0	+ 02	+ 02	100,000	0	— 02	100,040	— 01
5	100,010	+ 03	+ 04	+ 04	+ 05	100,000	0	— 05	100,030	— 03
6	100,000	0	+ 03	+ 04	+ 04	100,100	+ 1	+ 06	99,980	0
7	100,000	+ 04	+ 05	+ 04	+ 04	100,070	+ 07	+ 03	100,000	0
8	100,000	+ 03	+ 05	+ 05	+ 05	100,050	+ 05	0	100,000	0
9	100,000	+ 04	+ 03	+ 05	+ 04	100,010	+ 01	— 03	100,050	0
10	100,000	+ 02	+ 02	+ 02	+ 04	100,010	+ 01	— 03	100,000	0
11	100,000	0	+ 01	+ 01	+ 03	100,000	0	— 03		

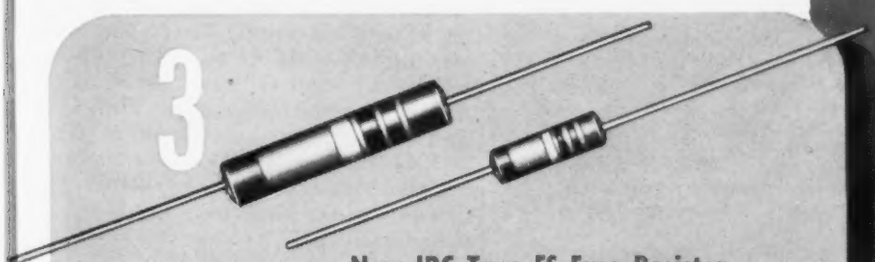
Tested side-by-side with competing resistors, new IRC Type WW's proved superior to all. Severe cycling and 100-hour load tests resulted in virtually zero changes in resistance. Other stringent tests proved Type WW's high mechanical strength, freedom from shorting, resistance to high humidity.

2 New IRC Type DCC (Deposited Carbon) Small-Size, High-Stability Resistors



This is the latest small-size addition to IRC's famous line of deposited carbon PRECISTORS. Conservatively rated at ½ watt, it combines *accuracy and economy*—assures high stability, low voltage coefficient, and low capacitive and inductive reactance in high frequency applications. Recommended for:—Metering and voltage divider circuits requiring high stability and close tolerance—High frequency circuits demanding accuracy and stability—Other critical circuits in which characteristics of carbon compositions are unsuitable and wire-wound precisions are too large or expensive. Type DCC meets Signal Corps Specification MIL-R-10509. Complete technical data in Catalog Bulletin B-7.

3 New IRC Type FS Fuse Resistor



This completely insulated unit functions as a resistor under normal conditions and as a fuse under abnormal conditions. Small, compact, stable, it can be wired into a circuit as easily as a molded wire-wound resistor. Bulletin B-3.

For full information on these products, or assistance in adapting them to any specific application, write IRC. Types BOC and DCC are currently available on short delivery cycles to manufacturers of military equipment only.

Boron-Carbon PRECISTORS • Power Resistors • Voltmeter Multipliers • Insulated Composition Resistors • Low Wattage Wire Wounds • Volume Controls • Voltage Dividers • Precision Wire Wounds • Deposited Carbon PRECISTORS • Ultra-HF and High Voltage Resistors • Insulated Chokes

IRC

Wherever the Circuit Says —WW—

INTERNATIONAL RESISTANCE COMPANY

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A. F. Smith & Co., Adv. Agency

Mail Coupon Today for Full Details of These New IRC Resistors

INTERNATIONAL RESISTANCE CO.,
407 N. BROAD ST., PHILADELPHIA 8, PA.

Please send me full data on the following checked items:—

- ☐ Type BOC Boron-Carbon PRECISTORS
- ☐ Type WW Precision Wire Wounds
- ☐ Type DCC Deposited Carbon PRECISTORS
- ☐ Type FS Fuse Resistors
- ☐ Name and Address of Nearest IRC Distributor

NAME.....

TITLE.....

COMPANY.....

ADDRESS.....CITY.....ZONE...STATE.....

AMPHENOL
Carries the Pulse
OF THE
Electronics INDUSTRY
. . . and if the cables and connectors in your equipment aren't of top quality, then the pulse will be weak and unreliable. Insist on Amphenol cables and connectors and be assured of maintained continuity and positive connection.
TEFLON CABLES developed by Amphenol are ideally suited for applications in the high temperature range. These cables operate without difficulty in temperatures from —100° F. to +450° F. They also feature extremely low loss and high voltage break down. Look to Amphenol for the entire series of RG Cables.
AUDIO CONNECTORS made by Amphenol are ruggedly built for severe usage and feature a unique watertight seal that provides full protection against water leakage. This type of connector is now standard on all Signal Corps communication equipment. Contacts are spring loaded and self-cleaning.
A-N CONNECTORS require a strict conformity to Army-Navy Specifications. Many of the now standard design features were originated and developed by Amphenol's extensive engineering staff. Amphenol's A-N Cable Assemblies provide the ideal combination of top quality components and high grade workmanship.
RF CONNECTORS are better if they are made by Amphenol—better because they are made better! Amphenol's RF Connectors have the quality and precision necessary in the most delicate and accurate of instruments, yet are rugged enough to meet the punishing demands of modern military aircraft and mechanized ground equipment.
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AMPHENOL

TELE-TIPS

(*Continued from page* 10)

HURRY-UP JOB—If the master minds of the Kremlin were delighted back in March when the "Voice of America" suddenly ceased broadcasting from Germany, their joy was shortlived. Immediately, America's Military Government sent a frantic SOS to RCA. RCA burned up the wires to Camden Copper. Then both converged on Electronic Mechanics in Clifton, N. J. Messrs. D. E. Replogle and F. B. Du Vall, president and vice-president respectively of Electronic Mechanics, moved swiftly. They stopped the shop turning over their complete facilities to the emergency. Big Mykroy insulation sheets were fabricated to exact specifications while officials waited. Also waiting was a giant military transport plane. Electronic Mechanics finished its assignment in four hours. Two days later the Voice of America was back on the air, to the further discomfiture of Iron Curtain countries.

FM REMOTE CONTROL—After three years of commercial operation, FM station WAJL of Flint, Mich., has been presented as an outright gift to University of Michigan. Waldo Abbot, director of broadcasting at the University, plans to operate the 400-watt Flint station by remote air control from the Ann Arbor campus, 60 miles away. Michigan U. is currently on the air with WUOM (FM), a 44,000-watter that hits the fringes of the Flint district. In the plan the University has presented to the FCC, remote operation will involve a receiver at Flint constantly tuned to the WUOM signal. Incorporated in the receiver is a detector unit which responds to a supersonic tone signal briefly placed on the WUOM carrier wave. This kicks in two one-minute relays and puts the station on the air. Monitoring of WAJL's signal will be done in Ann Arbor.

MORE TUBES, rather than less, will be needed as transistors develop, declares Dr. E. W. Engstrom, vice-president in charge of RCA's Princeton laboratories. "The transistor," he insists, "is not a substitute for electron tubes, but is an entirely new electronic tool." Transistors will eventually improve electronic devices, thinks Dr. Engstrom, to the point where more tubes will be needed and used, because more electronic devices wil be made!

(*Continued on page* 28)

ARE VSWR MEASUREMENTS YOUR PROBLEM?

–then the PRD type 275 voltage standing wave ratio amplifier is your solution

- A.G.C. maintains output constant within ± ¼ db for a ± 3 db variation in the r-f source.
- Wide VSWR ranges of 1:1.3, 1:3, 3:10, 10:30, and 30:100.
- High sensitivity—1.0 microvolts input for full scale deflection.
- Input circuit — Provides for either crystal or bolometer operation.
- Low input noise level of 0.03 microvolts.

Type 275 Amplifier is a high gain linear audio amplifier designed to accurately indicate voltage standing wave ratios. The application of expansion circuit techniques provides a full scale deflection of 1:1.3. This means greater accuracy for low VSWR measurements. The unit may be operated as either a broadband amplifier over the range of 300 to 3000 c.p.s. or as a narrow band amplifier at 500, 1000, and 1300 c.p.s. The square law meter, calibrated to read directly in db, and the high voltage gain of 140 db make this amplifier particularly suitable for microwave attenuation measurements with a bolometer r-f detector. Inquiries invited—address Dept. T6.

Polytechnic RESEARCH & DEVELOPMENT COMPANY · Inc

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WESTERN SALES OFFICE: 737 NO. SEWARD ST., HOLLYWOOD 38, CALIF.

Advancement in Emergency Communication

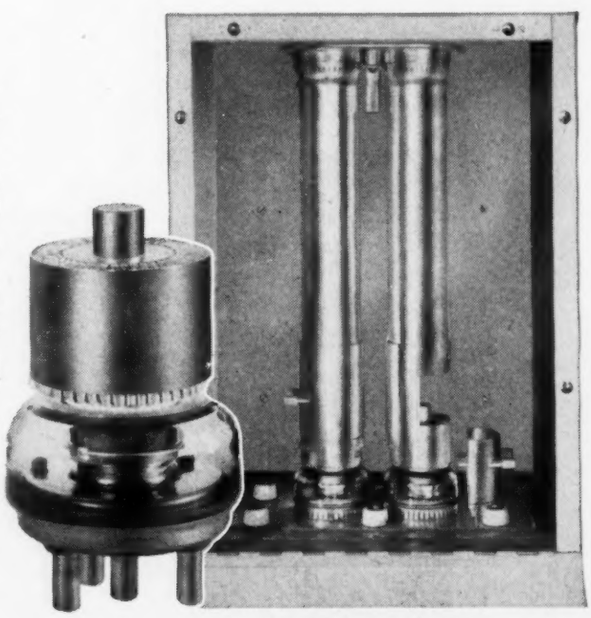
Eimac tubes fill key sockets In continuous service transmitters

REL type 757C transmitter

New and unique in civil emergency communication systems is the New York City Fire Department's five borough radio network planned to meet the threat of any emergency, including atomic attack. Transmitters designed by Radio Engineering Laboratories to give continuous operation are significant contributions to this electronic accomplishment.

Eimac's 2C39A triode is utilized in REL's type 757C point-to-point radio relay transmitter operating in continuous around the clock service at 900 mc. The 2C39A is used in two stages —as a tripler from 150 mc. to 450 mc. and as a doubler from 450 mc. to 900 mc. The 2C39A is a natural to serve in REL's 757C where it can perform as a frequency multiplier at ultra high frequencies with excellent operating efficiency. This compact, rugged, high-mu tube is designed for a variety of uses as a power amplifier, oscillator or frequency multiplier wherever dependability and durability are demanded.

Two Eimac 4X500A's give dependable performance in the REL type 715 emergency service transmitter. These external-anode tetrodes are in the power output stage of the final amplifier in each of the New York City Fire Department's eight main station 350 watt transmitters. Operating in the 150 mc. region the 4X500A's meet the challenge of 24-hour performance. Designed for application the 500 watt 4X500A has small size and low inductance leads which permit efficient operation at relatively large outputs well into VHF.



Power amplifier of REL's type 715

● ***Write our application engineering department for the latest information and technical data about these and other Eimac tubes.***

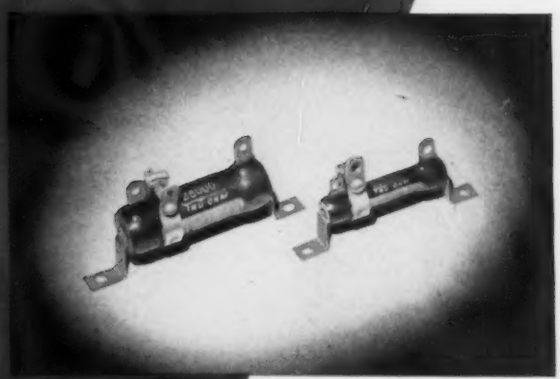
Follow the Leaders to Eimac TUBES

313

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA
Export Agents: Frazar & Hansen, 301 Clay Street • San Francisco, California

TRU-OHM
VITREOUS ENAMELED RESISTORS

The resistor line which is specified by engineers employed by the nation's foremost manufacturers of original equipment.



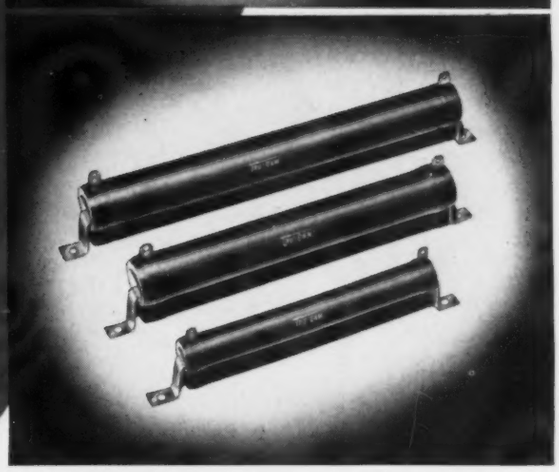
DELIVERY . . . two separate self-contained resistance plants guarantee prompt delivery.

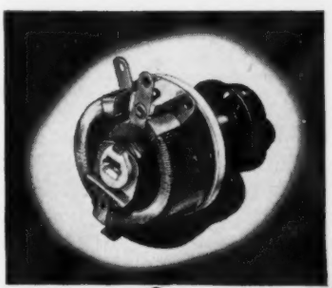
QUALITY . . . as the world's leading manufacturers of wire wound resistors, we assure you that only the finest engineering techniques and material are utilized.

PRICE . . . our tremendous manufacturing capacity enables us to offer resistors . . . in any quantity . . . at exceptionally attractive prices.

ENGINEERING . . . our factories include the most modern machine shops and engineering facilities. Our experienced engineering department is at your service to assist in designing any resistance unit to meet your requirements and to meet JAN Specifications.

We invite your inquiries.





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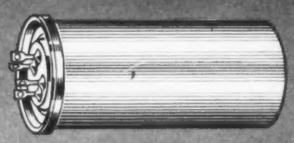

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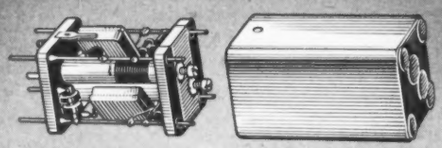

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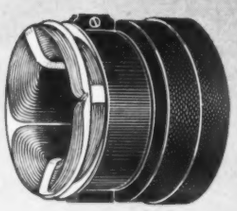
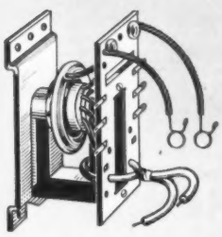


FLYBACKS



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TELE-TIPS

(*Continued from page* 24)

THREE - DIMENSIONAL TV pictures of microscopic specimens, were demonstrated by RCA at a recent meeting of the Federation of American Societies of Experimental Biology. The system is expected to find numerous applications in studies which benefit by the visual perception of depth. Two cameras mounted side-by-side view the object from slightly different angles and transmit their signals to two separate picture tubes. The two images are mutually perpendicularly polarized and superimposed by a semi-reflecting mirror on a single viewing screen. The stereoscopic effect is produced by observing the screen through polaroid spectacles which allow each eye to see one of the two images.

STEEL SHORTAGE?—The American Iron and Steel Institute reports that iron is abundant at ocean bottom in a mineral called glauconite, containing 23 per cent iron, a greenish, granular mineral, deposited slowly near the mudline along seacoasts at depths of 600 to 5,000 feet. When asked to place an estimate on the tonnage of iron thus available, a steel technical expert replied "The figure would require so darn many ciphers, it would dwarf the amount of iron ore taken from the Mesabi," which thus far has yielded about two billion tons of ore. Another interesting point cited by the Institute is the concentration in some sea creatures of alloying metals used in steelmaking. Lobsters, for example, concentrate cobalt; oysters concentrate copper; scallops concentrate nickel; sea slugs concentrate vanadium, while mussels and plankton concentrate manganese. Concentration is so low, however, that it is improbable that commercial use will be made of any of them in the foreseeable future.

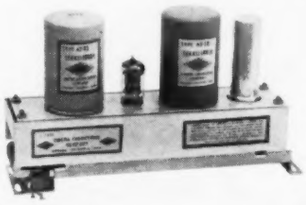
STANDARDIZED CASTOR HOLES in console and consolette TV model cabinets might not be a bad feature. Some manufacturers already have provisions for castors in their newer models, but standardization would make this item a TV accessory and at the same time simplify the dealer's stocking and merchandising problems.

GRINS—"I've found that a grin can get you out of more tight places than all the arguments in the world." —R. O. Eastman.

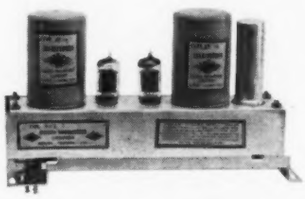
LABORATORY AUDIO AMPLIFIERS

PLUG-IN TYPE . . . unitized amplifiers

101-AX. A laboratory pre-amplifier. Uses single 12AX7 tube with triode sections in cascade. 42 and 32 db fixed gain. 80 db signal to noise ratio at maximum output. Intermodulation 2% at plus 4 dbm (using 12 kc and 40 cps at ratio of 1 to 4). Multi-impedance input and output. Feedback loop purposely does not include input and output transformers, thus allowing for complete line isolation and maximum flexibility. Complete details in Catalogue 16-C.



101-BX. A boom microphone pre-amplifier especially designed for low level dialogue pickup. For use in six to ten-foot pickups as in motion pictures and TV. Feature of design is 10 db more gain above hum and noise level than conventional pre-amplifiers. 50 and 40 db fixed gain. Intermodulation 2% at plus 4 dbm (using 12 kc and 40 cps at a ratio of 1 to 4). Feedback loop purposely does not include input and output transformers, thus allowing for complete line isolation and maximum flexibility. Complete details in Catalogue 16-C and Bulletin C-1016.



102-AX. A laboratory line amplifier. 42 db gain. 95 db signal to noise ratio at maximum output. Maximum input minus 18 dbm. Maximum output plus 24 dbm. Multi-impedance input and output. Intermodulation 2% at plus 24 dbm (using 12 kc and 40 cps at 1 to 4 ratio). Feedback loop purposely does not include input and output transformers, thus allowing for complete line isolation and maximum flexibility. Complete details in Catalogue 16-C.

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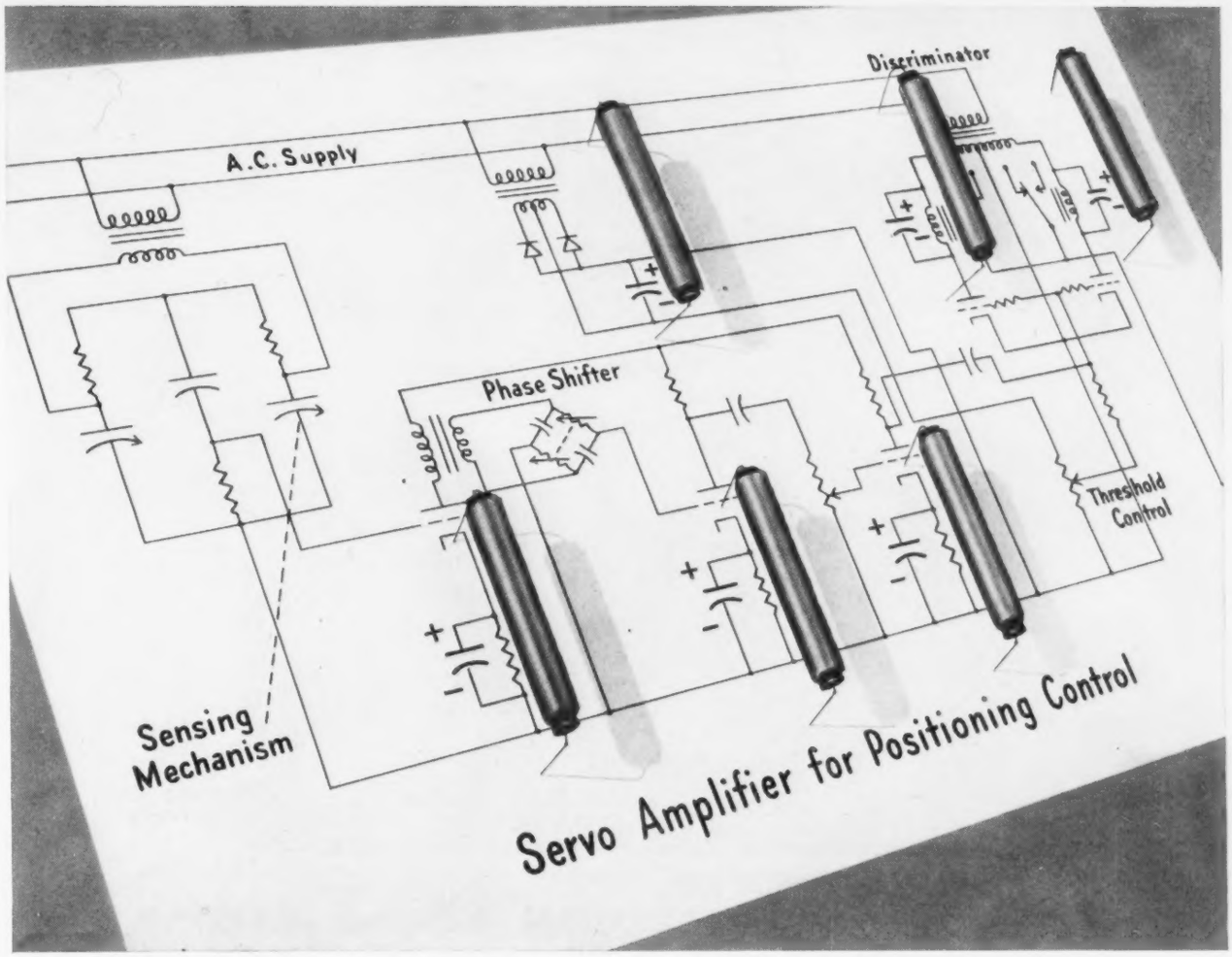

Tantalytic Capacitors get key role in "servo" circuit for positioning control

This servo-amplifier circuit controls the positioning of equipment which operates in high altitudes. Its capacitors must provide stable operation in widely varying temperatures. They must withstand considerable vibration. And their size and weight have to be kept to a minimum—without sacrificing operating life.

To meet these requirements, our capacitor application engineers recommended General Electric Tantalytic capacitors. These capacitors offer an operating temperature range from −55°C to +85°C —with at least 65% capacitance at −55°C. They contain a non-acid electrolyte—making them chemically stable and providing long operating life. They combine large capacitance with small size and weight. And they have the ability to withstand severe physical shock.

Other features of G-E Tantalytic capacitors include: exceedingly low leakage currents, extremely long shelf life and complete hermetic sealing. They're presently available in ratings from .1 muf to 12 muf at 150 volts d-c.

If you have a similar large-volume application where a low price is secondary to a combination of small size and superior performance—it will pay you to get in touch with us. You can get more complete information on the outstanding characteristics of Tantalytic capacitors from your local G-E representative. Or write General Electric Company, Section 407-309, Schenectady 5, New York. Ask for Bulletin GEC-808.

General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

407-309

ALL in ONE PACKAGE...

Distortion Analyzer
Noise Indicator Frequency Meter
and a Highly Sensitive
Voltmeter

the GR type 1932-A Distortion and Noise Meter $595.00

Here is a highly accurate, easily operated instrument widely used for the measurement of audio fidelity, distortion and noise. This instrument is very valuable for production-checking and adjusting attenuators, audio amplifiers, audio oscillators and radio receivers, and checking envelope distortion of oscillators up to 900 Mc. Among Its Many Uses Are:

- ★ Complete, continuous and accurate wave analysis of fundamentals from 50 to 15,000 cycles; with harmonic range up to 45,000 cycles when used with an oscilloscope — invaluable for checking hum, noise and distortion
- ★ Rapid selection of frequency — only one main tuning control and push buttons used
- ★ Indication of frequency with accuracy of better than 3%, making it a reliable frequency meter
- ★ Direct audio voltage measurements of 600-ohm systems over a range of +20 to −40 dbm
- ★ Highly sensitive voltage measurements from 1 mv to 100 volts, if calibrated first
- ★ Detection of noise levels down to 200 μv — inherent noise of instrument considerably less
- ★ Visual observation of distortion components with an oscilloscope; the distortion components at the output jack and the input to the analyzer are applied to the horizontal and vertical plates of a scope. The resulting lissajous figures give visual indication of the prevalent distortion harmonics. Simply by tuning through the frequency spectrum, a continuous visual indication of distortion present is obtained.

The accuracy, rapidity and ease with which a wide variety of measurements can be made has ideally adapted this instrument to the production checking of radio receivers, electronic instruments and components, as well as for everyday measurements in the communications laboratory.

Abridged Specifications

Distortion Range: *Push buttons select full-scale meter deflections of .3, 1, 3, 10 or 30 per cent distortion*

Noise Range: *Noise measurements made to 80 db below reference calibration level*

Audio-Frequency Range: *50 to 15,000 cycles for fundamental in distortion measurements; 30 to 45,000 cycles for noise and hum measurements*

Required Input Voltage: *between 1.2 and 30 volts for 100,000-ohm input; between 0.8 and 30 volts for 600-ohm input*

Residual Distortion Level: *100,000-ohm input — .05% (maximum distortion) below 7,500 cycles; 0.10% above 7,500*

Residual Noise Level: *Less than 80 db*

Accuracy: *Essentially ±5% of full scale for distortion, noise and dbm measurements*

GENERAL RADIO Company

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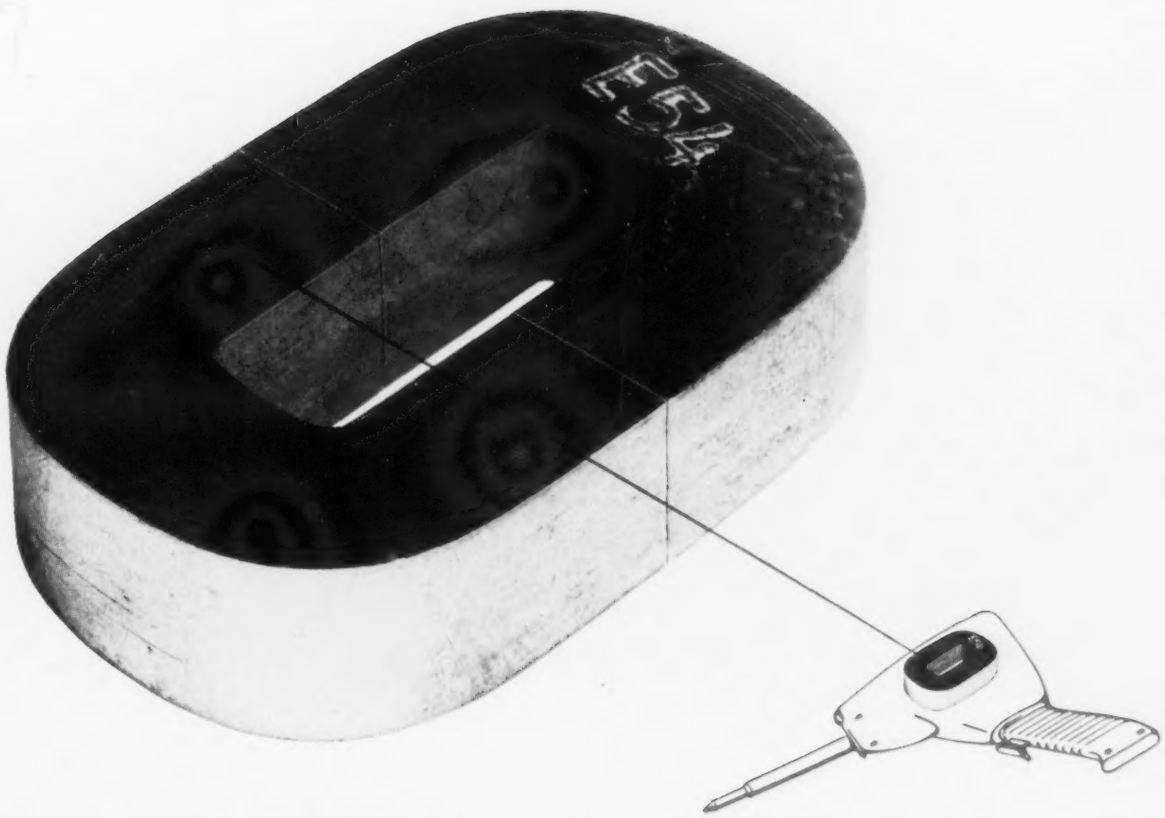


HIPERSIL® CORES

help revolutionize this soldering gun!

In designing their new Versa-Tool soldering gun, Phillips Manufacturing Company wanted a power unit that would provide instantaneous heat for off-on operation, yet operate on household voltage. A transformer was needed to build adequate amperage. But it had to be small, to fit into the handle . . . lightweight, for balance . . . reasonable in cost, to insure competitive pricing of the assembled unit.

Westinghouse Type RC Hipersil Cores provided the complete answer.

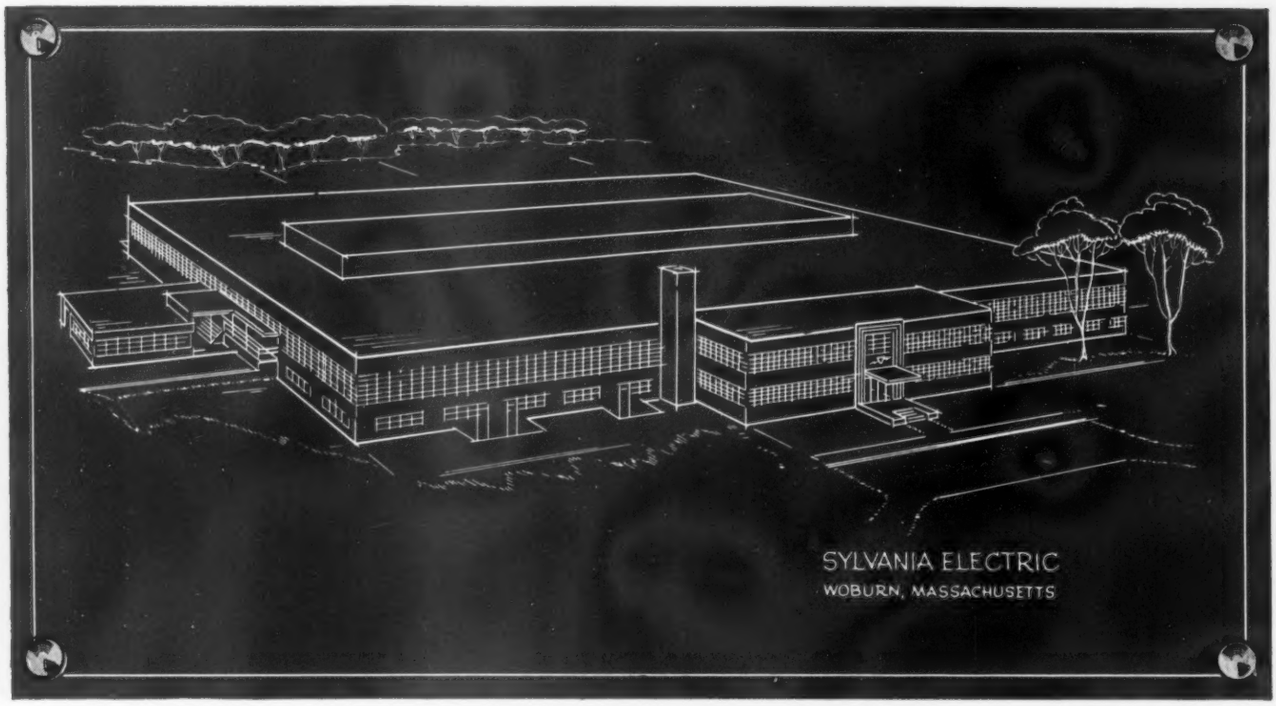
Because Hipersil Cores have greater flux-carrying capacity, Phillips engineers were able to cut size and weight of the transformer, effecting considerable savings in coil as well as core costs. But, better still, because the two-piece cores simplified assembly, manufacturing costs were slashed.

Hipersil Cores can cut cost, size and weight in all types of electrical and electronic transformers. Available in a wide range of sizes and shapes for low or high-frequency applications. Greater flux-carrying capacity, compact construction, plus the savings they effect in your manufacturing costs make them the best transformer cores on the market today. For more technical information on applying Hipersil Cores to your product, write to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-70628

YOU CAN BE SURE...IF IT'S Westinghouse

HIPERSIL CORES

Sylvania Electric Erecting New Headquarters For Its Electronics Division



Plant under construction at Woburn, Mass., 17 miles north of Boston. To make microwave components and semi-conductor devices.

To satisfy the growing need for electronic products, Sylvania will soon open a modern new plant at Woburn, Mass.

This building of advanced design will provide an additional 100,000 square feet of air conditioned laboratory and production facilities for the manufacture of electronic equipment and components. When completely equipped, it will represent an investment of four million dollars. The new plant will serve as headquarters for all present Sylvania electronic production facilities in the Boston area.

With these greatly expanded plant facilities, Sylvania is assuring you of the newest and best electronic components for radar, television, communications and industry.

SYLVANIA

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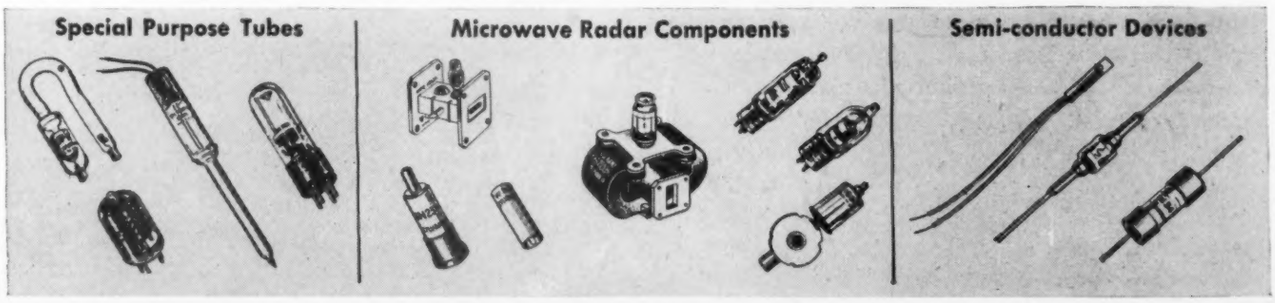
ELECTRONIC DEVICES; RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS'



TELE-TECH
RADIO-TELEVISION-ELECTRONIC INDUSTRIES

O. H. CALDWELL, Editorial Director ★ M. CLEMENTS, Publisher ★ 480 Lexington Ave., New York (17) N. Y.

Where Does Lifting of the "Freeze" Leave Us?

The end of the FCC-imposed "freeze" on the licensing of new television stations means, to the TV public: More stations; the opening of a new UHF band; the quenching of the thirst for transmitters in many non-TV cities (and hamlets, too!), and the launching of a plan which at last offers nation-wide television coverage.

The communications engineer's interest is centered in the engineering decisions made by the FCC, decisions which have been reached after many months of wrestling with the diverse, conflicting building-blocks which finally provided the foundation upon which the new television allocation rests. The factors making it difficult for the FCC allocation engineers were, first, the meager amount of propagation data available on VHF and even less on UHF, also the extra caution bred by sporadic, but severe, co-channel interference under the previous VHF allocation, and the awareness of the importance and finality of their decision.

More Information Needed

The key to easing the situation was more propagation data. But for some unknown reason the Commission, during the years of the "freeze," failed to instigate a broad program to secure such data. It did not even ask the TV industry for organized aid in collecting data.

The fundamentals of the new allocations, decided upon by the majority of the Commission, follows:

1. CHANNELS. VHF channels are numbered 2 to 13 (54 to 216 MC) and the UHF channels are numbered 14 to 83 (470 to 890 MC). See spectrum chart, pages 34, 35.

2. TABLE OF ASSIGNMENTS. Channels are allocated to cities and towns as shown in the "Table of Assignments" on pages 68-69 TELE-TECH, May, 1952. Thirty of the existing VHF stations have had their channels shifted.

3. MINIMUM CO-CHANNEL SEPARATION

Zone	Chs. 2-13	Chs. 14-83
Northeastern United States I	170 mi.	155 mi.
All areas outside Zones 1 and 3 II	190	175
Within 150 miles of Gulf Coast III	220	205

Minimum adjacent channel separation for all zones, channels 2 to 13 is 60 miles and 55 miles for channels 14 to 83.

General Consideration

4. POWER AND ANTENNA HEIGHTS. Maximum effective radiated power on channels 2 to 6 is 100 kw., channels 7 to 13 is 316 kw., channels 14 to 83 is 1,000 kw. The antenna height that may be used with maximum power is 2,000 ft. for VHF in Zones II and III and 1,000 ft. for Zone I. For UHF the height may be 2,000 ft. for all zones.

5. GENERAL. (a) No assignments are made for Stratovision or Polycasting, however experiments of this type may be made in the 782-890 MC band. (b) Allocations are made in the VHF and UHF for non-commercial, educational stations. (c) Two grades of service, A and B, are defined both in field strength and permissible co-channel interference. (d) Canadian and Mexican assignments are taken into consideration. (e) Allocations are made to avoid, as far as possible, these types of interference: i-f beat, intermodulation, adjacent channel, oscillator, sound image, picture image.

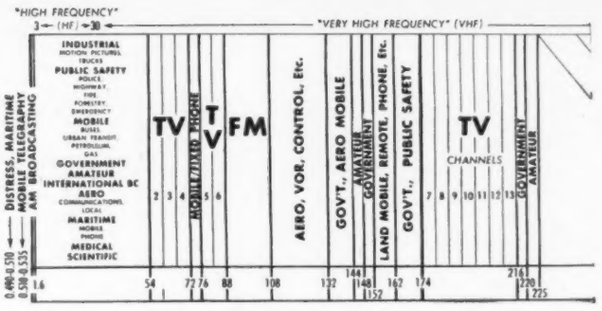
Now Let's Wait and See!

Is it any wonder that it took so long to formulate the allocation plan? Considering the data available, it is our belief that the Commissioners and their engineers did a very acceptable job on this new allocation. It is a "high-antenna high-power" plan which should give us better television reception. There are dissenters who claim that more stations could have been assigned without serious interference by reducing spacing, etc. No one knows for sure that this would have been the case, any more than we can be sure that the majority-accepted plan will work all over the U. S., year in and year out.

We are just *beginning* to learn the vagaries of VHF and UHF propagation. So let us accept the new allocations with an open mind, hoping for the best. The main thing now is that we have a plan, the "freeze" has been lifted, the FCC will soon be issuing construction permits and a new era of nation-wide television broadcasting for the U. S. A. has begun.

RADARSCOPE

Revealing Important Advances Throughout the Spectrum of Radio, TV and Tele Communications

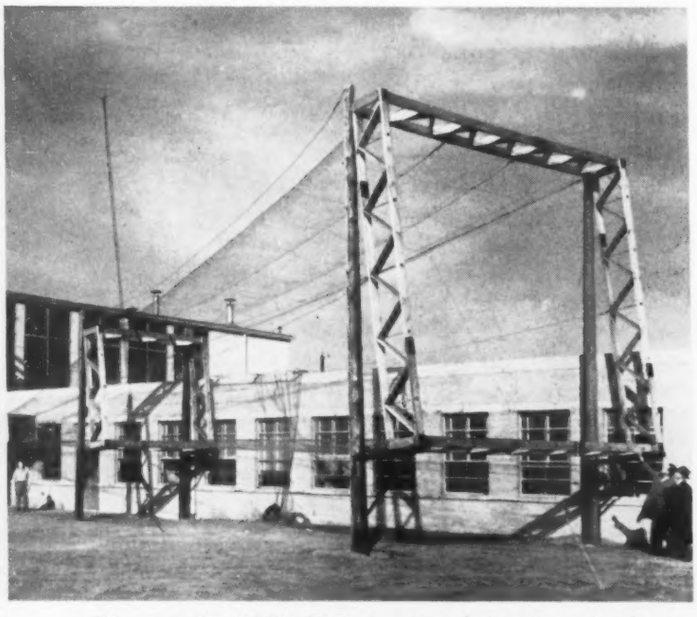


DEFENSE PRODUCTION

LIFT COPPER CONTROLS IN '54?—Although there is every prospect of a long-range controls program over the supplies of the alloying materials, including nickel, for at least five and possibly 10 years, the nation should be able to remove all restrictions on the use of the three controlled materials—steel, copper, and aluminum—in slightly more than two years, says Defense Production Administrator Manly Fleischmann. Forecasting substantially improved copper supplies in 1954, but no earlier, he repeats his earlier assertion that the copper situation still is "very bad," in contrast to some reports that it has been easing. He points out, however, that CMP "tickets" to the communications industry to obtain copper supplies have been increased recently because of "attrition"—the failure of some organizations with allotments to cash their controlled-materials-plan tickets.

STOCK PILING

NICKEL OUTLOOK GLOOMY—In his address before the AFCA keynote luncheon at the Bellevue-Stratford Hotel, April 24, Mr. Fleischmann painted a particularly gloomy picture of the outlook for the alloying materials, including nickel. He said that while the United States is in a position to boost sharply its production of the three major controlled materials it must look to other sources for major shares of the alloying metals. These include columbium, cobalt, and tungsten, as well as nickel. Should the nation get into all-out war, demands for these metals would rise far above the available stockpiles, he declared, adding that the U. S. could hardly fight a major war for a year if left with only its own production of those materials. The only answer, he emphasized, is substantially accelerated stockpiling, resulting obviously in continuation of strict controls for five to 10 years.



This month (June) Collins Radio plans to conduct another series of moon-echo tests from this 31-ft. paraboloid horn antenna which has a power gain of 21 db. Last Fall, with 20 kw at Cedar Rapids, Iowa, the 418-megacycle beam was directed at the rising moon and carried a message which, as reflected, was picked up by the Bureau of Standards, near Washington. The received signal was very weak, with a signal-to-noise ratio never exceeding 10 db at the receiver output.

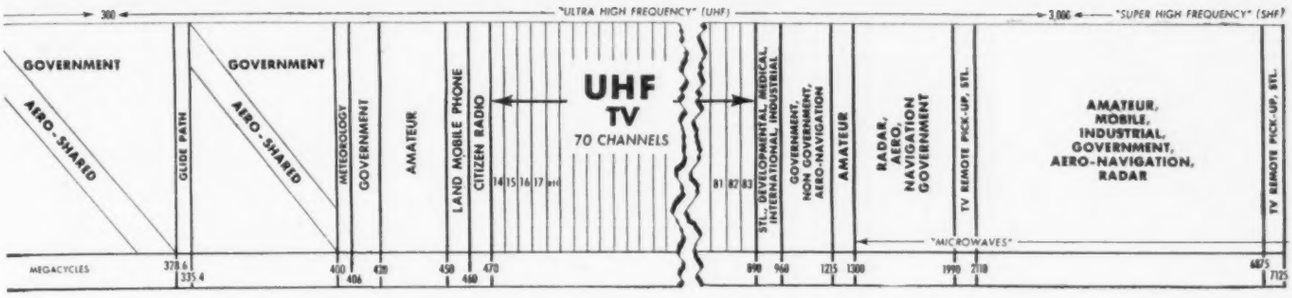
NEW COMPONENTS

ACCENTUATION on miniaturized equipment and the new fields that are constantly opening up within the electronic industries can be expected to result shortly in a new and radically different series of components. One concept concerns itself with the design of equipment in which nonlinear elements are employed, i.e., where given frequency changes do not produce linear impedance variations. (See TELE-TECH, April, p. 46; May, p. 56 and 57.) Another idea is to manufacture reciprocal components. Here, instead of considering ac circuit impedances on the basis of resistance and reactances, the terms become admittance, conductance and susceptance. What the physical appearance of the latter components might be, however, is still a matter of conjecture.

AVIATION

TO MOST OF US, says Dr. K. C. Black, Naval Air Development Center, Johnsville, Pa., the importance of electronics in aviation is a self-evident fact, and this point was emphasized at various times during the recent sessions of the Institute of the Aeronautical Sciences. Using money as a criterion, two examples were mentioned that are worth noting: One, that in one of the modern large bombing aircraft, 40% of the total cost is for electronic gear alone, and the other, that the electronic equipment in a large modern aircraft is more expensive than the entire aircraft of approximately 15 years ago.

This electronic equipment is, of course, not an unmitigated nuisance. Much of the performance of modern aircraft is entirely dependent on electronics. Communication and navigation are largely accomplished by electronics. As the speed and size of the aircraft increases, the operation of the control surfaces requires the use of servomechanisms that are either electronic in their entirety or are at least controlled by electronic devices.



Certain modern engines begin to have a complexity of controls that look as if they, too, will have to depend on programming methods that, in turn, will depend on electronics for their operation. Summing up these varied thoughts, electronics are inextricably woven into the modern aircraft design, and, according to most forecasts, this trend will continue into the indefinite future.

PLANAR TRIODES

LOW-COST UHF RECEIVING TUBES, long a troublesome problem for receiver design engineers, may soon become a practical reality. Several large tube manufacturers are now experimenting with completely automatic production of planar triodes, and the results are very encouraging. The costly factors in the manufacture of receiving tubes today lie in the high costs of labor, and in shrinkage caused by human error or mishandling. The construction requirements of planar triodes can be readily met with automatic production methods. Because these tubes do function well at UHF frequencies, and with production labor costs minimized, the outlook for UHF equipment comparably priced to VHF is brightened considerably.

ARMAMENT

GUIDED MISSILE'S complete flight may now be followed through use of a "chain" radar system developed by the Army Signal Corps. This system also makes it possible to obtain accurate ballistic data along the missile's flight path. The radar chain, located at the White Sands Proving Ground, Las Cruces, N. M., consists of several stations spread along the range at advantageous points. Master stations are located at the major missile launching areas and tracking is initiated simultaneously with the launching of a missile. As the missile travels along its course, data from the master station are relayed to the first relay station, automatically positioning the radar set at that station so that the set begins tracking the missile as soon as it comes into range. the process is repeated from station to station. Data from all stations are automatically and instantaneously relayed back to the master station, enabling observers to watch flight characteristics of the missile. A complete plotting board record is thus provided for use in later discussions and design planning. Range control officers maintain watch on the plotting board to assure that the missile is following its flight path. Photographic records are made of the radar dials and oscilloscopes. At the terminal end of the missile's flight, radar automatically trains cameras with telescopic lenses on the missile as it dives into the target, providing a record of this vital phase of the missile trajectory. All radar stations are linked together by a complex communications network, using both wire and radio, for rapid transmission of signals.

ENGINEERING

CENTENNIAL, 1852-1952—Completion of the 37-man Board of Directors who will head the Centennial of Engineering celebration to be held in Chicago, from July 1 to September 30, 1952, has been announced. The Engineering Centennial, which is being sponsored by 41 national and international groups that include in their membership the great majority of the engineering profession in the United States, will mark the 100th anniversary of the establishment of engineering as a recognized civilan profession in this country. Prior to 1852, when the American Society of Civil Engineers was founded, important engineering work in this country was conducted by military engineers. Prominent Directors include Gano Dunn, David Sarnoff, Herbert Hoover, Benjamin Fairless, Carlton S. Proctor, Titus G. LeClair, and many others.

Testing the British Admiralty's new underwater TV camera which is expected to be able to locate and inspect sunken ships on the ocean's bottom. Last year similar gear was used to identify HMS Affray at 280 ft. depth. Pressure-proof casing has been developed at Marconi laboratories, Chelmsford, England.

DEFENSE CONTRACTING OUTLOOK

$4.4 Billions for Our Industry

By LT. COL. STANLEY GERSTIN
Vice-Pres. & Gen. Mgr., Caldwell-Clements Manuals Corp., New York City

Based on reliable data from authoritative sources, TELE-TECH estimates that the three military services will obligate $4.4 billion for communication-electronic equipment in the calendar year 1952 as follows: Air Force—$2.2 billion; Navy—$1 billion; Signal Corps—$1.2 billion.

New procurement policies of the Small Defense Plants Administration affecting small business, and Defense Manpower Policy No. 4 channeling contracts to distressed areas will have far-reaching effect on radio-TV-electronic industry.

Revised, exclusive eight-page PROCUREMENT GUIDE included with this issue reveals latest heretofore unpublished data on procurement organization and personnel for Air Force, Navy and Signal Corps; engineering functions are added feature.

HERE are the answers to three major questions on Defense policy which are of immediate concern to the communications industry:

1. How much money will the Department of Defense spend for radio-radar-electronic equipment in the months ahead?

2. How will the newly issued policies defined by the Small Defense Plants Administration and Defense Manpower Policy No. 4 affect the communications industry?

3. What is the new electronic organization set-up in both procurement and engineering in the Air Force, Navy and Signal Corps?

Here are factual, reliable answers to all three questions. The data was obtained from authoritative sources as the result of intensive research, dozens of interviews, and on-the-spot investigations in *all* key military procurement centers. The final answers are a composite, and interpretation, of information obtained from highly reliable sources.

DOLLARS FOR DEFENSE

AIR FORCE: $2.2 Billion.

This is the amount of money it is estimated on good authority that the Air Force will *obligate* for all types of radio-radar-communication-electronic equipment during the calendar year 1952.

Approximately $700 million of the total expenditure will be for end items.

Approximately $1.5 billion of the total expenditure will be for electronic items to be integrated in guided missiles, fire control equipment, for replacement, parts, etc.

This rate of expenditure in the communications industry will most likely continue into 1953 since the bulk of obligations coming in the latter half of 1952 will carry over into 1953. This same carry-over condition will result in continuing high activity in 1954. Assurance of carry-over is further affirmed by circumstance requiring the Air Force to extend procurement of engines and air frames.

A significant break in defense requirements may not materialize until 1955. Even then, monies now being obligated will not be paid for a substantial portion of equipment until deliveries are made as late as 1955. This is evidenced by the fact that the Air Force is taking deliveries and making payments in 1952 on contracts issued in 1949.

Regarding distribution of the dollar within the communications industry, the bulk of it still goes to large business. But this is not by design. Responsible opinion in the Air Force is that further spreading of prime contracts for radio-radar-communication-electronic equipment to small business is not practical beyond the present degree. Highly specialized requirements for end items; electronics as an integral part of guided missiles and fire control equipment limit susceptibility of contracts to small business.

In a specific analysis of distribution of funds for construction of a four-engine plane, 40 percent of the funds went to sub-contractors; 16 per-

cent for purchased parts; eight percent for raw materials; 36 percent was spent within the prime contractor's plant.

Sub-contracting is the best bet for small business.

SIGNAL CORPS: $1.2 Billion.

This is the amount of defense dollars that will be spent by the Signal Corps for radio-radar-communication-electronic equipment in the calendar year 1952. This figure includes non-electrical accessory items such as wire for which the Signal Corps is the largest buyer. This $1.2 billion budget is actually divided into the following estimated commodities groupings:

Radio	30.0%	$354,900,000
Radar	8.0%	94,640,000
Meteorological ..	6.0%	70,980,000
Tel. & Tel. ..... (incl. test equipment)	25.6%	302,848,000
Test Equipment (other than telephone)	4.0%	47,320,000
Wire & Cable ...	22.0%	260,260,000
Photographic ...	1.2%	14,196,000
Radiac	1.5%	17,745,000
Miscellaneous ..	1.7%	20,111,000
	100%	$1,183,000,000

This budget includes $300 million for equipment which the signal corps purchases for the Air Force.

NAVY: $1 Billion.

This is the amount of money it is reliably estimated that the Navy (BuShips, BuAir, BuOrd, Office of Naval Research) will spend for radio-radar-communication-electronic equipment in the calendar year 1952.

Naval obligations to the communications industry are averaging $85 million a month. Monthly average to small business is $9 million. Of the entire estimated expenditure, small business will receive approximately $100 million; big business—$900 million.

Small business in the communications industry receives fewer dollars from the Navy than small business generally. The general average is 22 percent whereas the communication industry average is about nine percent to small business in dollar volume. This situation is the result of specialized requirements of the Bureau of Aeronautics.

BuAir is currently spending 50 percent of all Navy defense funds.

Only eight percent of BuAir requirements are susceptible of performance by small business. This compares with 22 percent for the entire Navy Department—and reflects the fact that the larger part of BuAir's aviation requirements are not susceptible of performance by small business.

MANPOWER POLICY NO. 4

The new Defense Manpower Policy No. 4 will have a terrific impact on regional economy. It has changed the entire military procurement picture.

What will Manpower Policy No. 4 do?

It makes mandatory award of negotiated contracts to businesses in distressed areas (surplus labor areas) if they can meet low bid prices of contractors in non-distressed areas.

This means that if a procurement officer requests bids from several bidders, a manufacturer located in a surplus labor market will be allowed to know and meet the low bid price should this low price come from a manufacturer in a non-surplus labor area. It means that a large manufacturer in a distressed area can be awarded a contract if he will meet the price of a small business in a non-distressed area.

Surplus (distressed) labor areas are determined by the Department of Labor every two months. These are known as Group IV areas. To these areas may be added surplus labor areas designated as such by the Department of Defense. The Department of Defense may also apply this policy to an entire industry regardless of its geographical location.

Manpower Policy No. 4 requires that a successful contractor in a distressed area must perform 60 per cent of the contract in his area.

The policy applies to negotiated contracts in access of $25,000.

It specifically recommends that the same procedures be followed in the case of contracts for less than $25,000.

It permits a "set-aside" practice whereby bids may be obtained on an advertised basis and only a portion of the contract awarded to the low bidder with the remainder "set-aside" for negotiation with contractors in distressed areas if they will meet the low-bid price.

If a contract is not awarded in a distressed area, a special report and reason for the action must be forwarded to the Department of Defense.

Contracts in discussion, but not yet awarded, are subject to this new policy.

If an area designated as a Group IV area (surplus labor) ceases to be classified as such at the time a contract is ready for award, it is held up and an effort is made to place the contract with a manufacturer in a surplus labor area.

Defense Manpower Policy No. 4 does not apply to formally advertised bids.

If the particular procurement is susceptible to performance by small businesses, they will have first crack at meeting the low bid price.

Until last month surplus labor areas included specified areas in

(*Continued on page* 135)

PROCUREMENT GUIDE--NEW ISSUE

A new issue of TELE-TECH's Procurement Guide is included as a special insert with this June, 1952 issue. It reveals reorganization of procurement operations by the Air Force, Navy and Signal Corps. The Guide includes, as an added feature, engineering organization and selected personnel supporting the procurement people of the three military services. In some instances, organization was so new at the time of preparation of the guide that department heads were not officially known. This will account for the omission of some names on the chart.

Special attention is invited to the reorganization by the Air Force of electronic procurement which is now a self-contained branch; to reorganization of research and development activities by the Air Force; to reorganization of Signal Corps commodity groupings and expansion of Navy electronic procurement functions.

Extra copies of the Procurement Guide, printed all on one side of a 21 x 30 in. sheet, for wall mounting, available from TELE-TECH *at $1.00 each.*

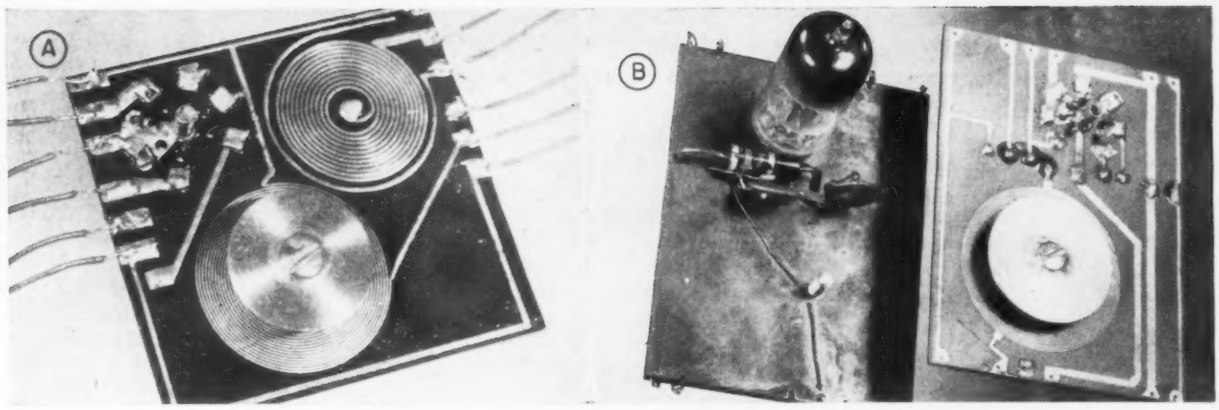


Fig. 1a, b: Two developmental printed i-f stages for 25 MC. Connectors and inductors are photo-etched; resistors and capacitors are dip-soldered

Printed Unit Assemblies

Etching and silk screening techniques reduce costs and conserve criti-
receiver manufacturing. Performance of printed stages compares favorably with

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RESEARCH in new construction for TV equipment faces strong conflict with existing methods which have established themselves in practice through gradual evolution. Materials, design practice, and methodology are so intertwined that significant changes introduced into chassis structure must necessarily be done with exacting consideration for the assembly line, purchased materials, and above all the net effect upon costs. Nevertheless, circumstances are pressing for the development of circuit printing methods suitable for TV. The impetus to improve manufacture comes not only from cost competition but also from shortages of metals and sporadically from components.

The application of unitizing to equipment design has generally followed two approaches, (1) the functional subchassis and (2) assemblies built around a single tube stage. The functional type designed as a plug-in containing several tubes, such as i-f amplifier, power supply, etc., has received some usage in TV construction. However, its primary contributions to convenience of repair and replacement are of greater importance where a great number of identical equipments are presented to closely knit service organizations, as in military or telephone central office operations. Single stage unit assemblies are primarily a means to improve assembly.

Two notable attempts to introduce a more logical uniformity in the assembly of radio and TV circuits may be seen in the single stage modules patented by Evans (Pat. 1,973,248) in 1934, and more recently by Mitchell (Pat. 2,472,021). Both of these are pre-assembled groups of conventional resistors and capacitors related in purpose to the performance of a tube and incorporated in the tube socket. A more familiar type of unit assembly is the "printed" interstage coupling unit built of silk screened resistors and capacitors on a high-dielectric ceramic base. This form has become well known through the Bureau of Standards—Centralab work and is now present in many sets as the integrator circuit. The silk screened unit in its commercial form is, of course, attached to tube sockets by wire leads.

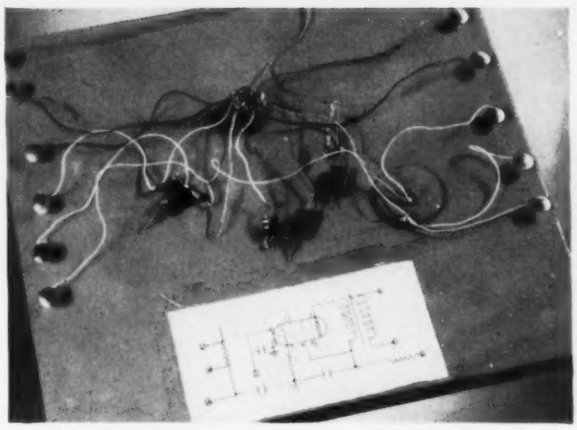
Adapting Technique to Circuit

Each of the silk screening or etching techniques, as we now see them, is best adapted to particular circuit elements. The screening of resistors and capacitors of commercial tolerances on high dielectric plates has become commonplace. However, inductors for 40 MC and less occupy too much area to be screened on ceramic and are of doubtful use on plates of high dielectric. On the other hand, selective etching of metal-clad laminates and die-stamping processes are producing inductors and interconnecting wiring competitive to wire wound elements. The ease of soldering to etched circuits is also attractive but it is not generally feasible to etch bypass and coupling capacitors from clad-laminates. The cure of resistors screened on etching stock is also limited by the thermal stability of the plastic base.

By utilizing the intrinsic process and material advantages of the silk screen and selective etching methods in the development of a unit assembly, *completely printed* TV circuits are possible.

In Fig. 1 are shown two developmental models of a printed 25 MC video i-f stage. The connectors and inductors, both single spiral and bifilars, are photo-etched in an essentially planar, cascade design and the clips from a wafer type tube socket are incorporated directly into the plastic base. The above-deck placement of resistors and capacitors permits assembly to be accomplished by a dip-soldering operation, during which the coils are protected with a high-temperature tape mask. Both models have bifilar transformers under the brass tuning slug and one has also an r-f choke in the heater line.

The choice of flat etching stock as a base for the unit was not an arbitrary one. Eighteen three-dimen-



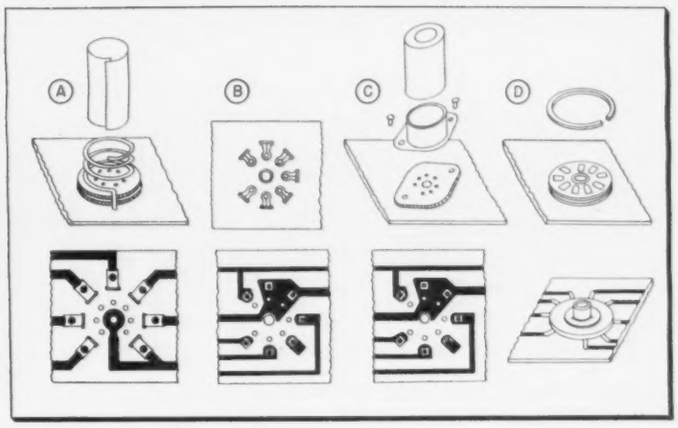


Fig. 2: (L) Pasteboard models for visual study of various shapes. Fig. 3: (R) Design sketches of dip-soldered assemblies incorporating tube sockets

for TV

cal materials in standard circuits

sional pasteboard models of various shapes were constructed for examination, four of which are shown in Fig. 2. Flat stock was selected because of its ready availability, because of the facility of dip-soldering and riveting additional components thereto, and the convenience of a flat master negative. A doubt might arise as to the actual saving of critical material achieved through the use of sheet copper but the photoetching process provides opportunity for accurate design of each conductor and inductor dimensions to the actual current carrying loads, which usually results in a slight saving in copper when compared with the universal use of one or two sizes of hookup wire. While design standards have not yet been established, the current carrying capacity of etched conductors is remarkably high when compared with a wire of corresponding cross-sectional area.

Temperature Check Results

In Table I are shown the results of temperature check made on a 2 μh spiral, which indicates that it could be operated with a current density in excess of 52,000 amp/sq. in. of conductor cross-section without excessive temperature rise.

The problem of designing masters for fine, etched bifilar coils has no doubt been one of the factors retarding a more general acceptance of etched circuits. A draftsman has to spend considerable time with compass and straightedge to draw a spiral, and at best accuracy of design is poor. To eliminate this handicap, a turntable apparatus resembling a transcription machine has been fitted with two pens to enable the drawing of master spirals, either single or bifilar, to be made in a matter of minutes. A wide selection of diameters, line width, space width and turns ratio makes possible a rapid improvement in design.

Master drawings are reduced photographically to a negative transparency of exact dimensions and this transparency is used to photoetch the coils by the now well known process. Table II gives specifications and test data for several etched coils designed for video i-f use. Tuning is accomplished by a brass screw with an oversize head. Although the presence of the disc tends to lower Q, the reduction is fairly constant over the tuning range necessary to stagger-tuned circuits.

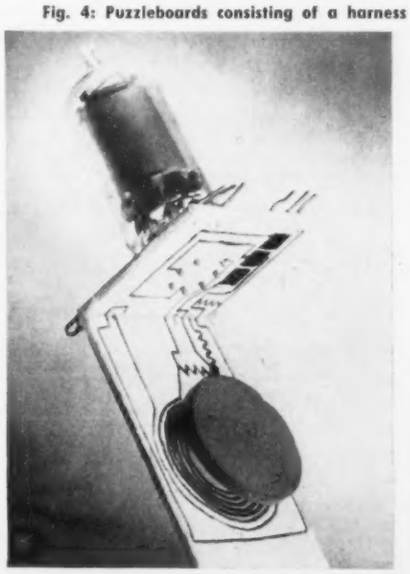
Of general interest to engineers concerned with printed circuits, four methods of incorporating tube

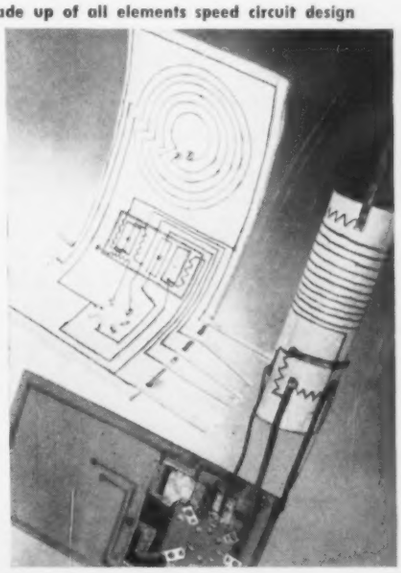
TABLE I: CURRENT CAPACITY OF AN ETCHED COIL

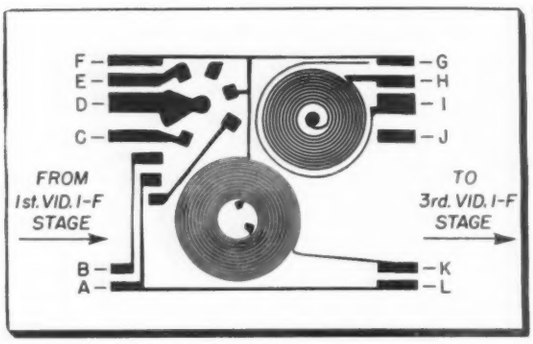
Coil data:					
Material .... Copper on 1/16 in. XXXP laminate			Space between lines ..... .009 in.		
Coil Diam. .. 1 in.			Inductance ..... 2.0 μh		
Line width .. .024 in.			Conductor cross-section .. 29 x 10^{-6} in.		
Line depth .. .0012 in.			Nearest comparable wire size #35 AWG		
Current, Amps. AC	1.5	2.0	3.0	4.0	5.0
Duration of test	2 hours	2 hours	2 hours	5 min.	5 sec.
Remarks	Coil cool to touch	Slightly warm	Copper became dis-	Plastic backing smoking	Coil did not open or buckle

Current density at 1.5 amps = 52,000 amps/sq. in. of conductor cross-section.

Fig. 4: Puzzleboards consisting of a harness made up of all elements speed circuit design







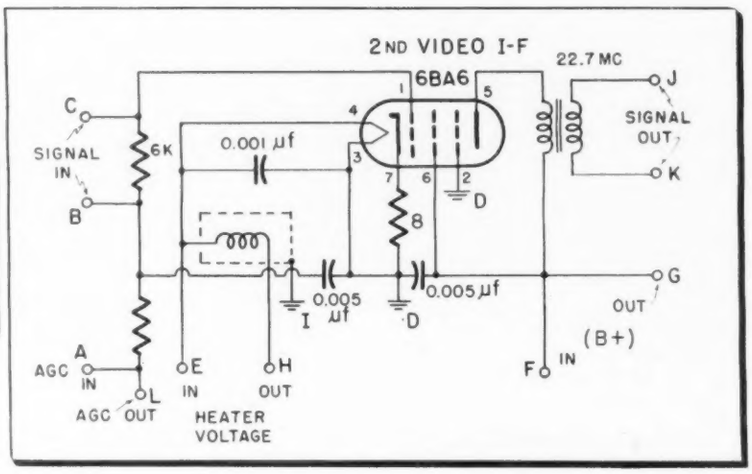


Fig. 5: Printed circuit layout and schematic of 25 MC i-f stage. Jump connections, except from center of coils, have been eliminated. Feed-through busbars go to B+ and agc

sockets in assemblies to be dip-soldered have been devised by modifications of commercial sockets and parts. Sketches are shown in Fig. 3.

Two basic construction features are essential:

1. The socket must have mechanical retention to supplement soldering; and

2. The lug ends of the clips have to emerge horizontally and in contact with the conductors on the base material for soldering to be possible. The designs illustrated accomplish this with a minimum of riveting or fastening.

The most direct approach, Fig. 3a, is to use a type of wafer socket having long lugs which may be inserted through punched holes in the deck and bent flat against the conductors. A very neat arrangement results if similar but smaller clips are separately inserted into the etched laminate. This construction, Fig. 3b, was used in the module under discussion. Some pin clips require compression between two wafers for proper functioning and with this type of clip the upper wafer may be retained as shown in 3c. Molded sockets may be adapted by revising these so that they insert from beneath the deck as in Fig. 3d. To do this the top flange is replaced by a snap-ring and an underside flange is provided by addition of an insulated washer which also serves to compress the lugs flush against the circuit connections.

Conventional Tube Shielding

Tube shielding, when required, may be of the conventional type, riveted to a grounding strip or area provided in the etch pattern; or, as shown in Fig. 3. shield fastening can also be adapted to solder-dip assembly without recourse to rivets.

Planning the circuit layout for two-dimensional reproduction is an essential step in printed circuit design and much of this effort is spent in the elementary but time-consuming process of eliminating crossovers. Sketches are helpful, but three-dimensional models as previously shown are almost mandatory for proper evaluation of a proposed configuration. To facilitate the reduction of layouts to simplest form

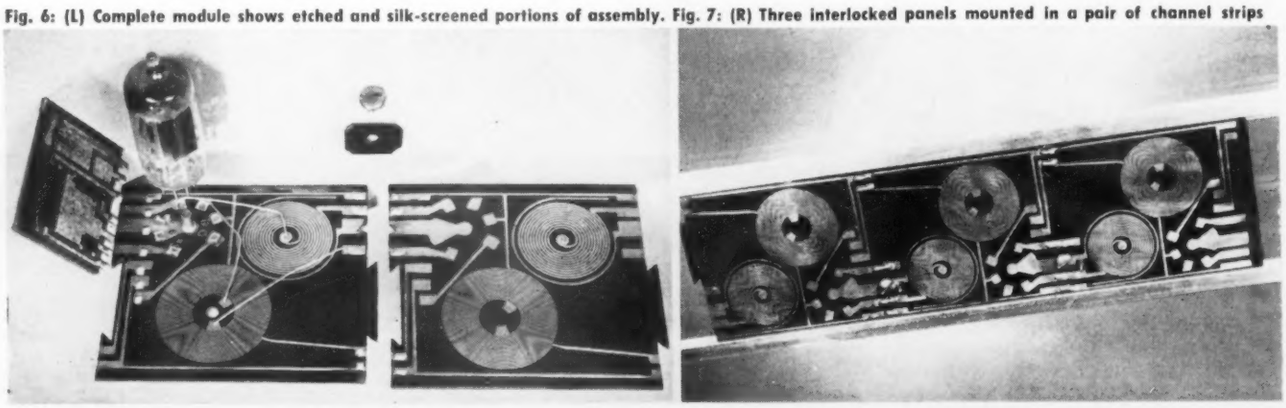
(*Continued on page* 112)

TABLE II: ETCHED COILS FOR 25 MC IF

Winding	Etching Stock	O.D. In.	I.D. In.	Line width In.	Total number of turns	Q	L h
Single	XXW laminate 1 oz. copper	1	19/64	0.018	11	62	2.35
Single	XXXP laminate 1 oz. copper	1	19/64	0.020	11	70	2.18
Single	XXXP laminate 1 oz. copper	1	19/64	0.024	11	65	2.05
Bifilar	XXP laminate 2 oz. copper	1 1/8	15/32	0.020	8 8	P-46 S-45	P-2.0 S-1.9
Bifilar	XXW laminate 1 oz. copper	1 1/2	31/64	0.010	12 1/2 12 1/2	P-48 S-49	P-4.8 S-4.75
Bifilar	XXW laminate 1 oz. copper	1 7/32	29/64	0.020	10 10	P-58 S-54	P-2.9 S-2.75

P = Primary Winding S = Secondary Winding

Fig. 6: (L) Complete module shows etched and silk-screened portions of assembly. Fig. 7: (R) Three interlocked panels mounted in a pair of channel strips



From CP to TV with the FCC

Step-by-step procedure shows potential telecaster how to obtain construction permit, time extension, test permission and operating license

WITH the lifting of the freeze, the rush for UHF and VHF TV facilities is on! While the FCC has provided the period to July 1st during which no applications will be acted on, it behooves the potential telecaster to file his application as soon as possible, and to insure that his application is correct when filed the first time. With these thoughts in mind the following notes are presented for the benefit of engineers who have not previously had dealings with the FCC, and who may find themselves deeply embroiled in the intricacies of FCC procedure.

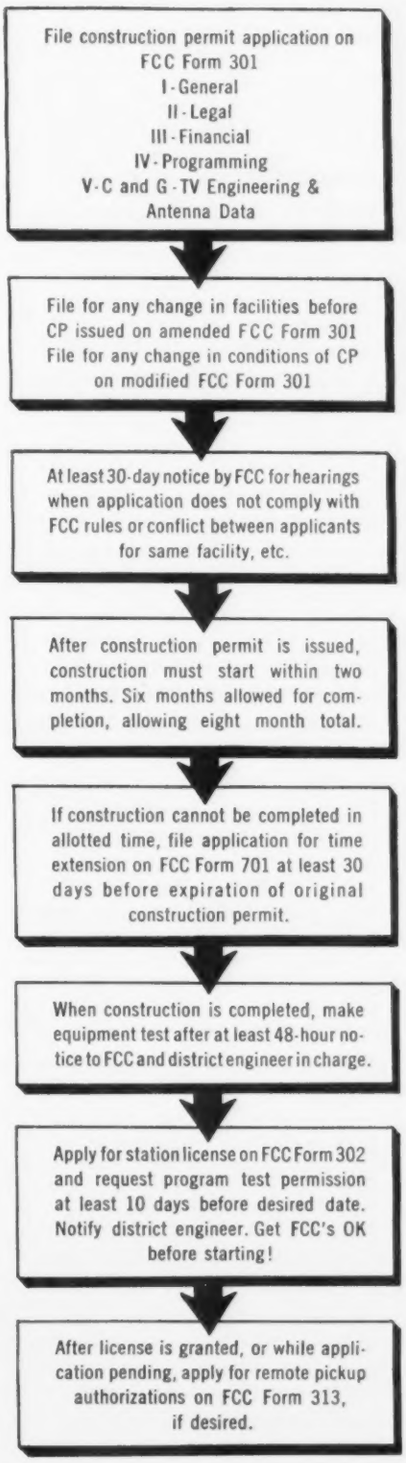
Filing for CPs

The first step in obtaining a TV authorization is to file an application for a construction permit on the somewhat involved FCC Form 301. The engineer is mainly concerned with Section V which contains the engineering specifications. However, he should be familiar with the other sections.

Section I: Covers the general facility requested. Section II: Legal qualifications of the applicant. Section III: Financial qualifications of the applicant. Here the engineer has to provide some cost information for use by management in filling out the form. Section IV: Proposed programming by the new station. Section V: Engineering is divided into four parts: V-A for AM, V-B for FM, V-C for TV and V-G is an antenna specification sheet, in duplicate, one copy going to the FCC and one to the CAA. Parts A and B of Section V of the form can be discarded; Section C requires attention in great detail.

The following is an abstract of the essential engineering information required in Section V-C of Form 301 describing the proposed TV station.

ANTENNA:
1. Modification of or proximity to existing broadcasting structure.
2. Make and type of visual and aural antennas.
3. Number of sections, db power gain and directivity data.
4. Height above ground and sea level.
5. Section V-G requires extensive tower construction, terrain and other information related to obstructions to air navigation.


File construction permit application on FCC Form 301
I - General
II - Legal
III - Financial
IV - Programming
V-C and G-TV Engineering & Antenna Data
File for any change in facilities before CP issued on amended FCC Form 301
File for any change in conditions of CP on modified FCC Form 301
At least 30-day notice by FCC for hearings when application does not comply with FCC rules or conflict between applicants for same facility, etc.
After construction permit is issued, construction must start within two months. Six months allowed for completion, allowing eight month total.
If construction cannot be completed in allotted time, file application for time extension on FCC Form 701 at least 30 days before expiration of original construction permit.
When construction is completed, make equipment test after at least 48-hour notice to FCC and district engineer in charge.
Apply for station license on FCC Form 302 and request program test permission at least 10 days before desired date. Notify district engineer. Get FCC's OK before starting!
After license is granted, or while application pending, apply for remote pickup authorizations on FCC Form 313, if desired.

Chronological flow chart of FCC procedure for placing TV broadcasting station in operation

TRANSMITTERS:
1. Make and type of visual and aural transmitters.
2. Power rating in dbk and kw.
3. Means for determining and maintaining power specified in application.

MONITORS:
1. Visual and aural modulation monitors' make and type.
2. Frequency monitors' make, type and accuracy.

TRANSMISSION LINE:
1. Make, type and description.
2. Size, length and total power loss in db.

OPERATION:
1. Transmitter power output in dbk and kw.
2. Multiplexer loss in db.
3. Transmission line input in dbk and loss in db.
4. Antenna input in dbk, power gain in db, and erp in dbk and kw.
5. Predicted minimum field strength coverage of city in dbu.

LOCATION:
1. Studio and transmitter sites.
2. Detailed map of area within 15 mi. radius of transmitter.
3. Several profile graphs showing important terrain topography.
4. Aerial photographs of transmitter vicinity.
5. Compliance with minimum station separation requirements.

FCC Action

On receipt of the completed form it is listed as "received for filing" by the FCC. If on initial examination there are no apparent errors it is assigned a file number.

If, after the original application has been filed, it is found necessary or desirable to make a change in the facilities requested an *amended* Form 301 must be filed. In sections of the original form in which there have been no changes since the original was filed, it is not necessary to resubmit the information. It is only necessary to write in those sections "no change see application, FCC Form 301 file numbers so and so, dated _____."

If it is necessary to request a change in the conditions of the construction permit after one has been issued it is necessary to file an application on FCC Form 301 for a *modification* of construction permit, following the above procedure for amending.

No cost is involved in filing forms

(*Continued on page* 132)

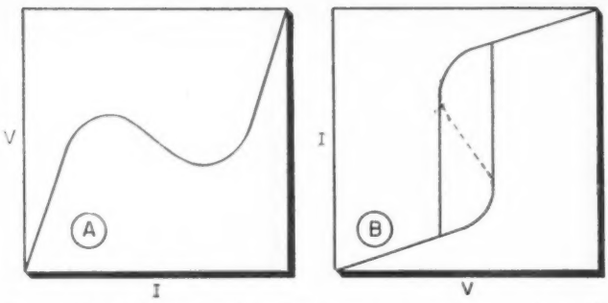


Fig. 1: (Left) Current and voltage curve of nonlinear resistor (A) current and (B) voltage the independent variable

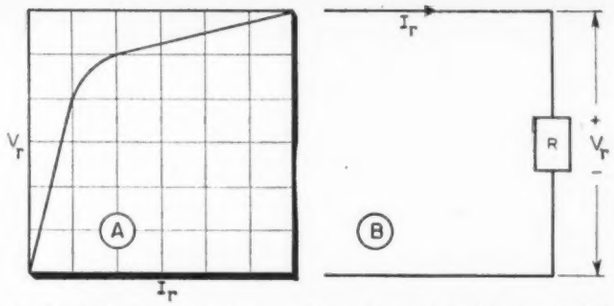


Fig. 2: (Right) The basic circuit and the characteristic (A) of a typical nonlinear resistor

Shaping Nonlinear

Devices such as computers and limiters using an increasing num- feedback around resistor that lead to coordinate transform which

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Cambridge, Mass.

IN circuit work, nonlinear resistors are finding an increasingly important role. Their use in rectification, clipping and frequency multiplication has long been known and understood. More recently, the increased interest in computers, phase-meters, etc., has made it necessary to investigate means for controlling, to some extent, the characteristic curves of these devices.

Nonlinear Resistor Specification

The nonlinear resistor is essentially a two terminal network whose current vs. voltage curve is not a straight line. This deviation from linearity is generally expressed graphically. For a true resistor, the shape of this curve remains constant regardless of the speed at which the independent variable is changed. For purposes of simplicity (in order to avoid nonlinear differential equations) we shall assume that the elements discussed here are true resistors whose current-voltage curves are invariant.

In the graphical representation of nonlinear devices, it is often important to specify which variable is the independent variable and which is the dependent variable. Since this statement is in conflict with usual procedure it's worthwhile noting the reasoning behind it. Fig. 1 demonstrates the current-voltage relationship of a hypothetical non-linear device. The abscissa in each case represents the independent variable, while the ordinate represents the dependent variable Fig. 1-A illustrates a smooth albeit multi-valued curve, while Fig. 1-B illustrates the hysteretic character obtained when the voltage becomes the independent variable. It is evident from this demonstration that the question of variable dependence is important when discussing nonlinear elements. Fortunately the importance is generally confined to multi-valued and hysteretic curves. In order to avoid confusion we shall follow the usual system of using the abscissa to define the independent variable while the ordinate represents the dependent variable.

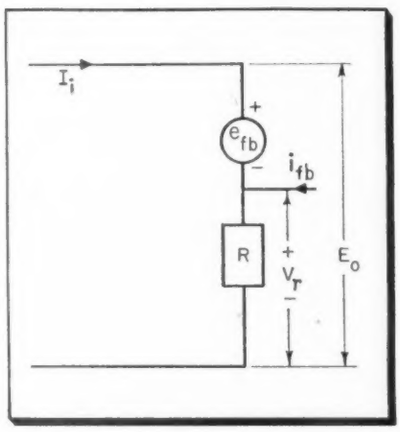


Fig. 3: Generalized circuit with feedback

In Fig. 2 is shown the circuit which we shall use as our basis for the following analysis. We assume that the voltage vs. current curve of the nonlinear resistor is as shown and that it is desirable to alter this curve. The means of alteration will be the introduction of current and voltage feedback. We can express the relationship between the voltage across the nonlinear element, V_r and the current, through it, I_r, as some function. In general, this function will only be known in graphical form, so we indicate it analytically simply as:

(1) $\quad V_r = f(I_r)$

The circuit of Fig. 3 represents a general circuit using a feedback voltage and a feedback current to obtain a new voltage-current curve:

(2) $\quad E_o = f'(I_i)$

E_o is the "output" voltage and I_i the "input" current. If we assume that the feedback about the nonlinear element follows a linear relationship then we may write:

(3) $\quad e_{fb} = \rho I_i$

and

(4) $\quad i_{fb} = \gamma V_r$

Under this assumption of linear feedback we can now seek the relationship between the f' of (2) and the f of (1)

(5) $\quad E_o = V_r + e_{fb}$

(6) $\quad I_r = I_i + i_{fb}$

Combining (6), (5), and (1) we have:

(7) $\quad E_o = f(I_i + i_{fb}) + e_{fb}$

and from (3) and (4)

(8) $\quad E_o - \rho I_i = f(I_i + \gamma V_r)$

From (8) we can see the relation between E_o and I_i. In order that the curve of Fig. 2 represent the circuit of Fig. 3, then, all that is necessary is to relabel the ordinate and abscissa $E_o - \rho I_i$ and $I_i + \gamma V_r$ respectively. This step is, of course, apparent from

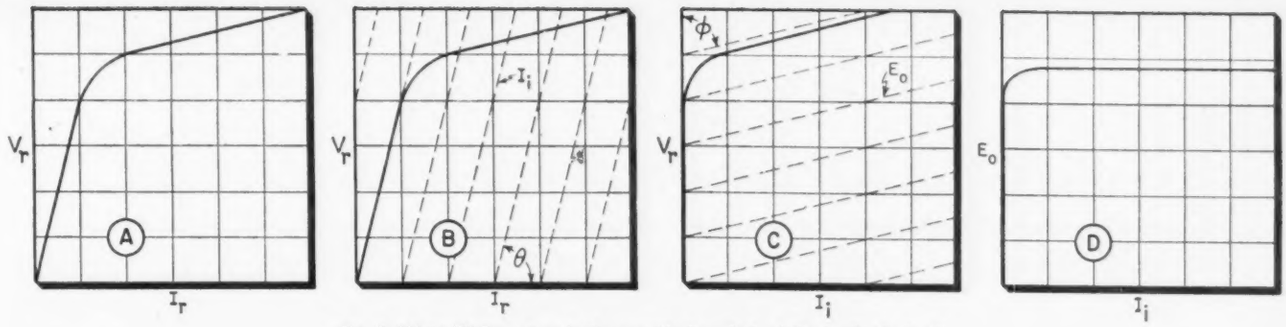


Fig. 4: (A) to (D) Four steps in the graphical analysis of the feedback circuit

Resistor Characteristics

ber of these components. Technique considers two types of linear makes wide variety of behaviors with single resistive element possible

the nature of the circuit of Fig. 3. We are not interested primarily in this curve but in a curve relating E_0 and I_i directly. The relabeling of the axis, however, indicates a straightforward graphical method for transforming the curve of Fig. 2 to the desired curve.

Figure 4A shows the curve of Fig. 2 repeated for convenience. To convert the abscissa to I_i, it is necessary to reduce the abscissa of every point in the $V_r - I_r$ plane by (according to 8) γV_r. Note that such a step produces no displacement of the points along the horizontal axis. A simple means for performing the required shift of each point in the plane is to leave the horizontal axis untouched, and redraw the lines of equal current as skewed lines instead of vertical ones. The degree of skewing is determined by the value of γ and the angle θ is given as:

(9) $\theta = \cot^{-1} \gamma$

Any point on the plane may now be replotted on a graph with conventional vertical ordinate lines by simply reading off its value on the skewed coordinate graph. This has been done in Fig. 4B.

In order to relabel the ordinate axis E_0 rather than V_r, it is necessary to increase the ordinate of each point in the $V_r - I_i$ plane (of Fig. 4C) by ρI_i. We may perform this operation by skewing the ordinate lines, which, as before now provide new lines of constant voltage. Figure 4C show this construction for a negative value of ρ. The angle if given as:

(10) $\phi = \cot^{-1} (-\rho)$

Again we find it simple to redraw our graph on conventional orthogonal coordinates by a point-by-point method. This has been done in Fig. 4D.

Although the curve in Fig. 4A would perform the function of clipping, for example, to some extent, it is evident that the curve of Fig. 4D will perform it much more satisfactorily.

Equivalent Circuits

The foregoing section gave a graphical method which could be used to compute the behavior of a nonlinear device with linear feedback. We are now able to inspect the operation of providing feedback around a two terminal network in terms of physical operations. Equations (3) and (4) gave the values of feedback voltage and current as:

(3) $e_{fb} = \rho I_i$

(4) $i_{fb} = \gamma V_i$

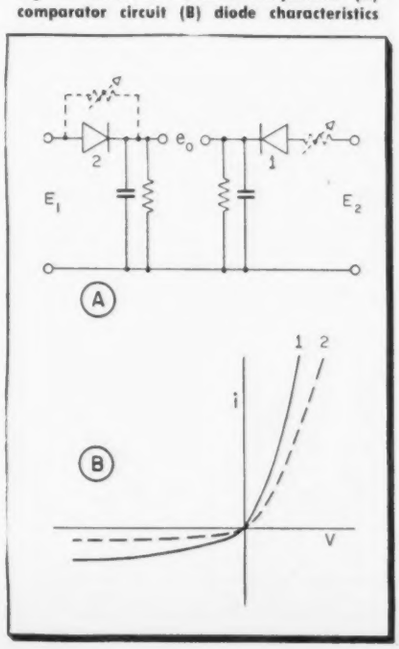
It is evident that ρ has the dimensions of a resistance and γ those of a conductance or reciprocal resistance. We can visualize the circuit of Fig. 3 as having a resistor tied across the terminals marked V_r. This resistor which is in parallel with R will be called R_p. Similarly e_{fb} may be replaced by a series resistor which we call R_s. We may now relate the values of R_p and R_s to the other parameters. From (3) (4) (9) and (10) we have:

(11) $R_s = \rho = \cot \phi$

(12) $R_p = 1/\gamma = -\tan \theta$

Thus we see that the application of feedback described in the example of Fig. 4 may be expressed in terms of shunting the nonlinear element with a negative resistance whose value is tan θ and inserting a series of resistance of value cot ϕ in the circuit.

Fig. 5: Balanced rectifier comparator (A) comparator circuit (B) diode characteristics



The concept of using resistors as the feedback elements is of real practical use in many cases. A typical example of this is the problem of obtaining a balanced rectifier system to use as a voltage comparator. Fig. 5 illustrates a circuit for this purpose. In order to achieve accurate balance in a servomechanism it was desired that e_0 be zero when E_1 and E_2 were equal in magnitude. The "dynamic range" of the system is defined as the ratio of the maximum value of E_0 which exists when E_2 is zero to the maximum value of E_0 when $E_1 = E_2$. This definition corresponds

(*Continued on page* 88)

High Stability Computer

Series-regulated system furnishes 100 and —100 volts at 750 ma. Center-tap circuit develops bias to maintain equal overall loads to ground

By FRANK R. BRADLEY & RAWLEY D. McCOY
Reeves Instrument Corp., 215 East 91st St., New York 28, N. Y.

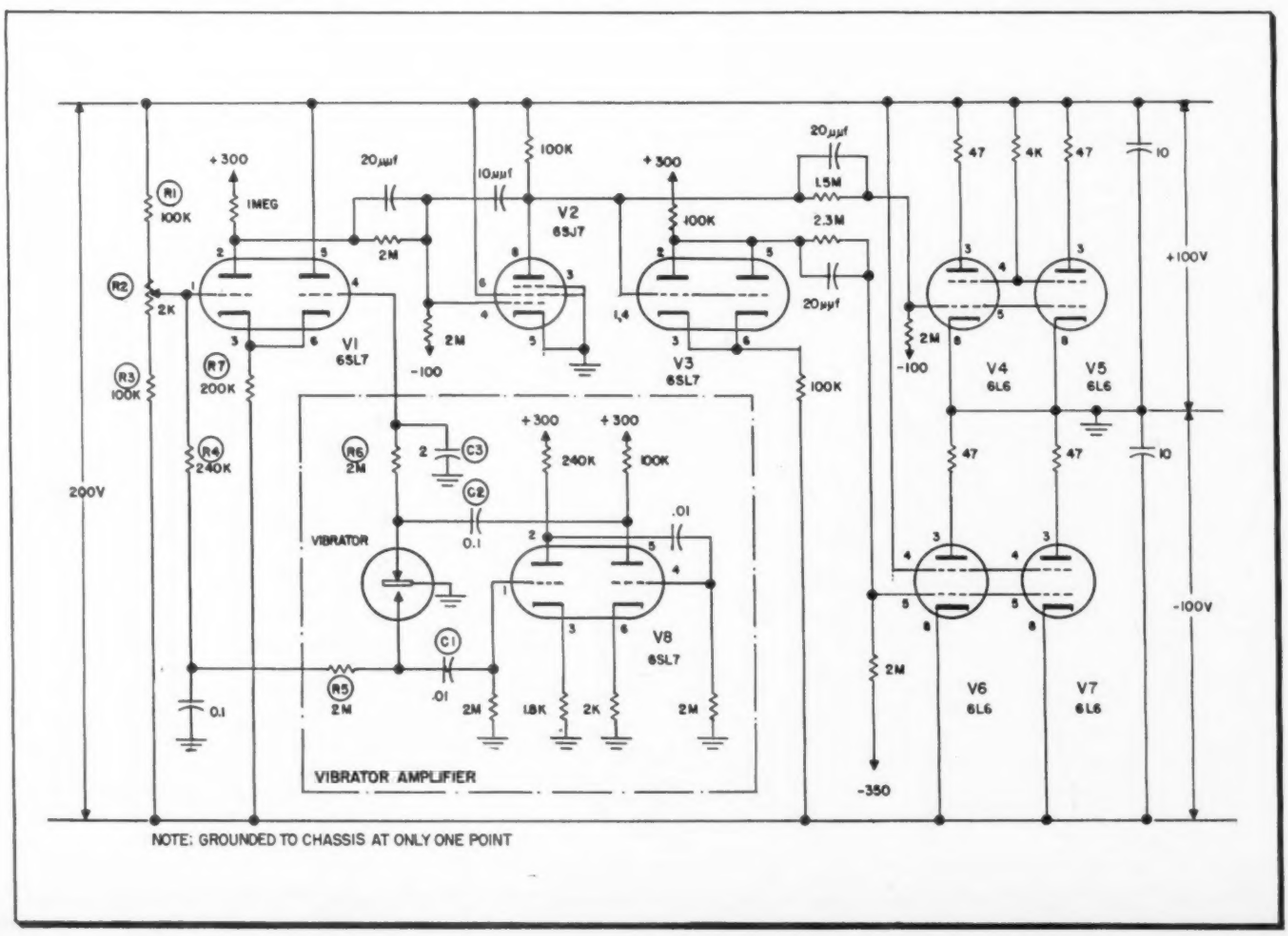
IN analog computation, one of the primary requisites for accuracy is power supply stability. For this reason the Reeves Instrument Corp., in conjunction with its REAC computing equipment, has developed an extremely accurate and stable high-capacity power supply to be used as the reference supply for an entire computing installation. This supply furnishes precision +100 and —100 v. at a combined capacity of 750 ma and is capable of supplying loads at an unbalance of up to 200 ma. A single stable voltage may thus be used for computing reference purposes throughout an installation, eliminating power supply variation from computing accuracy consideration.

The unit is basically a series-regulated full-wave rectifier with an electronic center-tap. The regulator provides a series-regulated output of 200 v. and the center-tap circuit refers the midpoint of the 200 v. output to ground (see Fig. 1). It is a conventional high-gain series circuit in which excellent regulation is achieved by using an unusually high gain regulator amplifier and shaping the open loop frequency response curve with net-works to prevent oscillation.

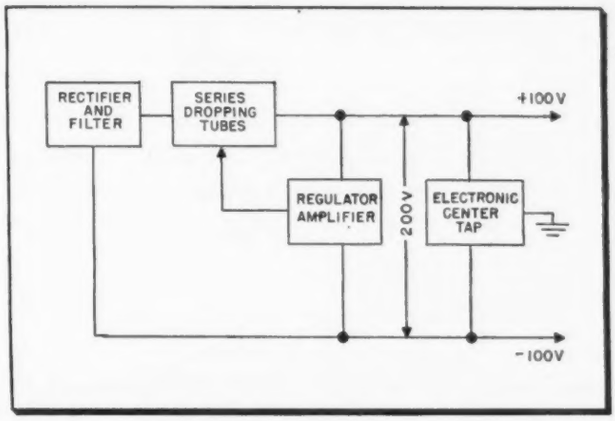
Of particular interest is the center-tap circuit shown in Figs. 2 and 3. This circuit consists of dynamic loads in parallel with the supply loads, the dynamic loads varying as required to hold the legs of the supply centered about ground. If, for example, the Load 2 resistance is decreased (by the addition of more load), the 200 v. regulated supply tends to drift upward because the paralleled resistance of Load 2, V6 and V7 is less than the paralleled resistance of Load 1, V4 and V5, and the load junction is grounded. As the supply drifts upward, the center-tap circuit develops biasing voltages which decrease the impedance of V4 and V5 and increase the impedance of V6 and V7, maintaining equal overall loads to ground on the plus and minus legs of the supply.

The sensing circuit is a high-gain dc amplifier. The amplifier input is

Fig. 1: Schematic diagram of computer reference power supply shows series-regulated full-wave rectifier with electronic center tap



Reference Power Supply



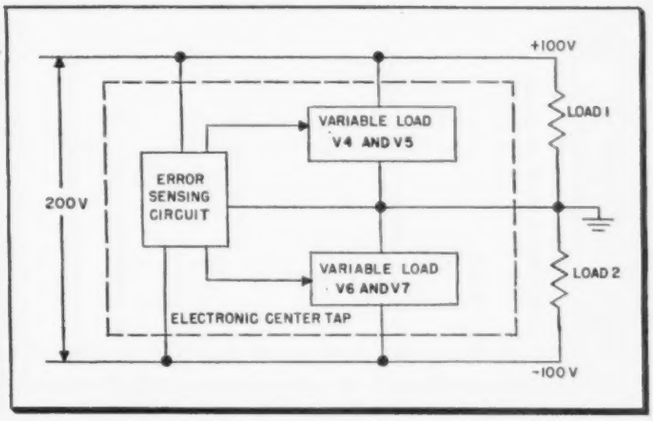


Fig. 2: (L) Supply circuit includes rectifier, dropping stage, amplifier and center tap. Fig. 3: (R) Electronic center tap with parallel loads

developed from voltage divider R1, R2 and R3 and coupled into the first amplifier stage V1. The output at the number 2 plate of V1 is further amplified by V2. The output of V2 is supplied directly to the control grids of V4 and V5 and through unity-gain phase inverter V3 to V6 and V7. The change in voltage at their grids causes the load tubes' impedances to change as previously described, driving the output voltage so as to make the amplifier input, as tapped from the voltage divider, equal to zero.

Ideally, the amplifier V1 input is at ground potential in which case, because little or no grid current flows, the R2 tap is halfway between the plus and minus legs of the supply. Any tendency of the supply to change with respect to ground produces a dc voltage at the arm of R2 which, as has been described, is amplified and drives the load tubes to oppose the change thus holding the input voltage at zero.

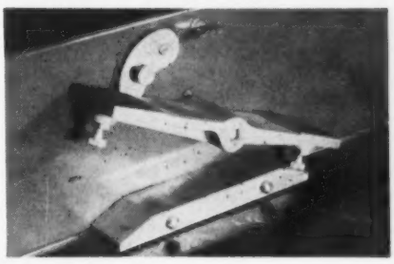
Drift Susceptibility

The amplifier is a dc amplifier however, and is therefore susceptible to drift because any slight variation in dc level at the input stage is amplified by the succeeding stages. The effect of drift is to produce a steady state condition with the voltage at the input grid different from zero by an amount necessary to compensate for the drift, giving a corresponding inaccuracy in the levels of the output voltages with respect to ground. Compensation may be achieved by offsetting R2 to balance the outputs with respect to ground; this, unfortunately, does not compensate for drift which occurs in operation following the setting.

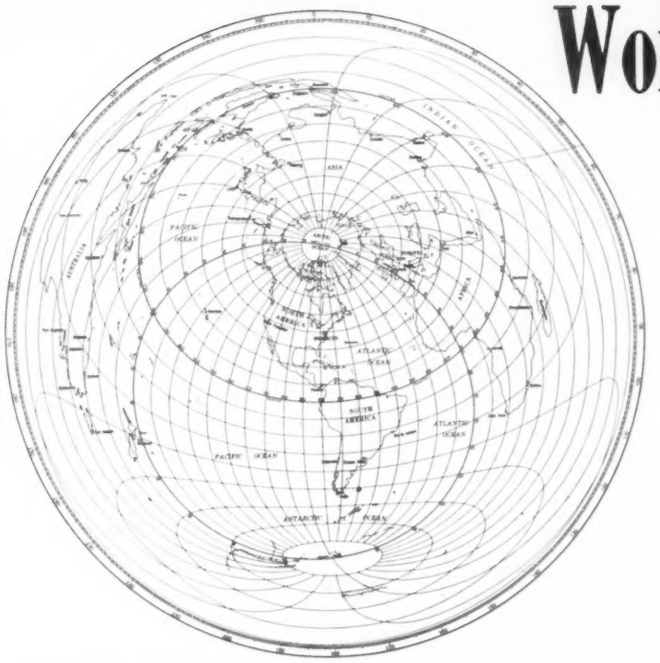
To eliminate this problem, a vibrator drift reduction system is used. The voltage existing at the grid of V1 is coupled through R4, R5 and C1 to the number 1 grid of V8. The junction of R5 and C1 is grounded on alternate half cycles at a 60-cycle rate by the vibrator so that any dc voltage existing at the grid of V1 is chopped, appearing at the number 1 grid of V8 as a 60-cycle square wave. This voltage is amplified in the two stages of V8. The output at the number 5 plate is coupled through C2 to the other chopper arm which grounds the output at a 60 cycle rate, rectifying the ac output. The half-wave rectified dc is filtered by R6 and C3 and the resultant dc supplied to the number 4 grid of V1. This amplified error voltage is added to the number 1 grid input by means of common cathode resistor R7. Thus any deviation at the input of the amplifier from ground is amplified by a chopper type amplifier not susceptible to drift which is effectively in series with the basic dc amplifier. This reduces the drift by a factor of the chopper amplifier gain and increases the overall amplifier gain to give better regulation.

Computer Safety Switch

THE adjustment and modification demanded by large computers often require the engineer's attention inside racks containing numerous "hot" terminals. In order to prevent personnel injury caused by accidental application of power, the analog computer Typhoon, developed by RCA and presently installed at the Naval Air Development Center, Johnsville, Pa., incorporates a convenient foot pedal power switch in each equipment rack. The switch is mounted on a shaft at the bottom of the cabinet. The shaft extends through the rack to pedals at front and rear. Stepping on one of the pedals cuts off electrical power in the particular cabinet, allowing shock-free adjustment. Power may again be applied to the rack only by stepping on the same pedal which originally opened the supply circuit, eliminating the possibility of having a coworker inadvertently place his colleague between B+ and ground by depressing the opposite pedal.



World-Wide Standard



Thousands of observations of standard transmissions on 5, 10 and 15 MC show how location, frequency, seasons and time of day affect global coverage

By E. L. HALL,
National Bureau of Standards,
Washington, D. C.

THE results of many thousands of observations during 1950 on reception of standard frequency transmissions from the National Bureau of Standards experimental station WWVH, Maui, T. H., and the more powerful station WWV, Beltsville, Md., indicate an increase in standard frequency coverage by WWVH and no marked difficulty arising from the operation of both stations on the same frequency. Observations were made by several government agencies and by individuals at numerous points in the U.S., Alaska, Pacific area, Australia, and Jamaica.

Before proceeding with a detailed account of these observations and conclusions concerning world-wide coverage of standard frequency and time services, it would be worthwhile to present a brief history of the establishment of these services.

In 1923, NBS began transmissions of standard frequencies from WWV. These transmissions were announced in advance, and consisted of several groups of frequencies, each of which was available for a few minutes in the evening once a month. Later the service was gradually expanded until it became available continuously 24 hours per day on eight frequencies. Reports from many government agencies and other organizations and individuals cooperating with NBS indicated that adequate coverage was not obtained all of the time in certain areas during some seasons.

This led to the establishment of a second standard frequency station on an experimental basis on the island of Maui, T. H., in Nov. 1948. This station, WWVH, operates on three of the frequencies of WWV, i.e., 5, 10, and 15 MC, with a power of 400 watts. The frequency of WWVH is adjusted and maintained with reference to WWV by means of special piezo oscillators of high stability and special monitoring techniques.

One of the questions which immediately presented itself was whether interference would be experienced by users of these stations because of simultaneous operation. Another question related to how much the standard frequency coverage was extended by the second station.

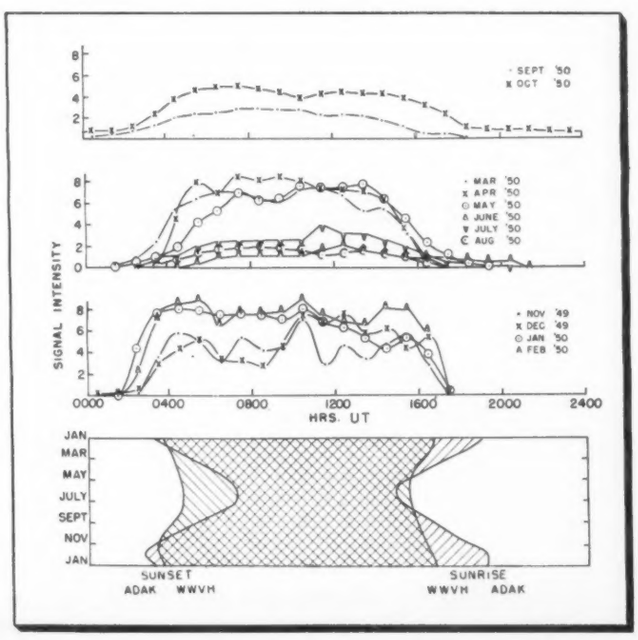
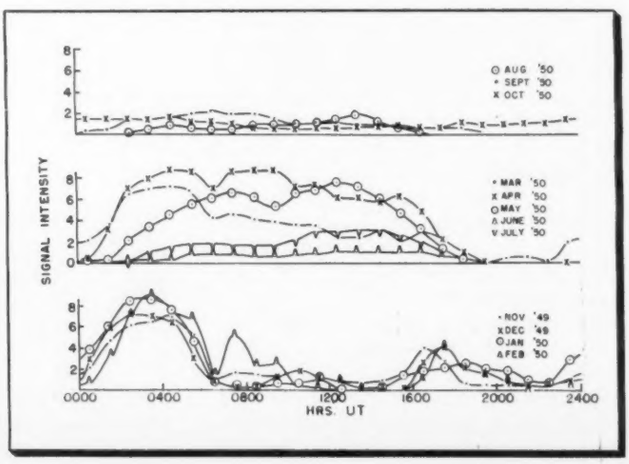


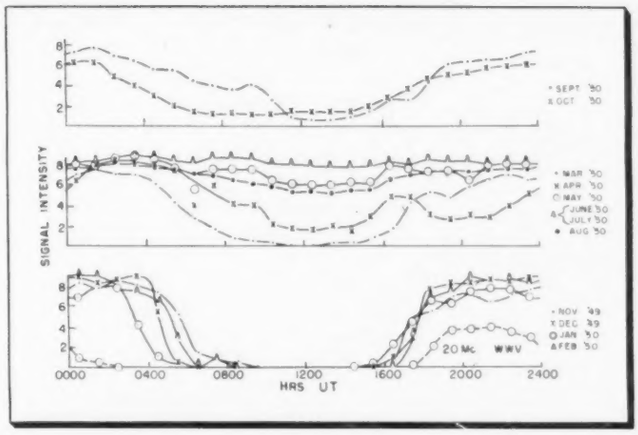
Fig. 1: Reception of WWVH on 5 MC at Adak, Alaska, Nov. 1949 through Oct. 1950

Fig. 2 (below): Reception of WWVH on 10 MC at Adak, Nov. '49-Oct. '50



Frequency Broadcast Reception

PART ONE OF TWO PARTS



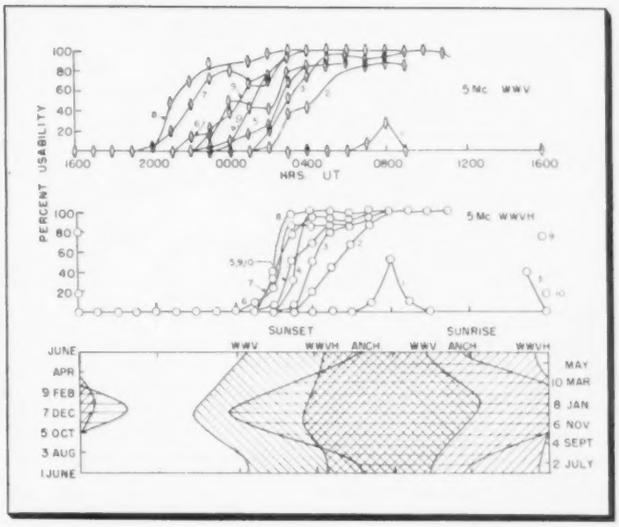


Fig. 3: (L) Reception of WWVH on 15 MC at Adak, Nov. '49-Oct. '50; WWV on 20 MC, Jan. '50. Fig. 4: (R) Reception of WWVH and WWV at Anchorage, June '49-March 50. Sunrise and sunset shown for three locations.

Station JJY, Tokyo, Japan, gives standard frequency broadcasts on 4 and 8 MC. Late in 1949, experimental standard frequency broadcasts were made on 5 MC for three weeks and were intended to give practical data on 5 MC reception in Japan and other far eastern areas not adequately covered by WWV or WWVH.

Reception of WWV and WWVH

Because reception of WWV is not always satisfactory in England and Europe, the National Physical Laboratory on Feb. 1, 1950 began an experimental standard frequency transmission from Rugby, England for a half-hour each day on 5 and 10 MC from station MSF.

The Civil Aeronautics Administration submitted over 13,000 observations on reception of stations WWVH and WWV from Sept. 1949 through July, 1950. The reports came from three main regions which may be defined as the west coast, Alaska, and islands of the Pacific Ocean, regions which are likely to benefit from transmissions from station WWVH. Points in Alaska included Anchorage, Annette Island, Fairbanks, and Nome. The Pacific islands were Canton, Guam, Midway and Wake.

The results are summarized in Table I, where "Better," "Worse," and "Same" refer to the reception of standard frequency and time signals as changed by the addition of station WWVH. "Better" means either a stronger signal or extension of the number of hours per day that standard frequencies are available. "Same" indicates no marked change. To be truly "Same" the tests should have been made throughout the 24 hours. Very few of the data met this requirement, but were interpreted on the basis of conditions at the times of observation. The intended meaning of "Worse" was that standard frequency reception was actually worse at the location because of WWVH's interfering with WWV. 1½% of observations were marked "Worse," but it is believed that many of these were erroneous. The data in Table I indicate 20% better reception for the west coast, 67% better for the Alaskan area, and about 88% better for the Pacific area.

Observers in the field offices of the FCC were well trained and equipped for accurate measurements. The several thousand observations reported were divided into two groups for the United States, those east of the Rocky Mountains comprising ten localities, and those west of the Rocky Mountains, of which there were seven localities. Observations were also made at Fort Hase, Oahu, T. H.

The results are summarized in Table II where "Better," "Worse" and "Same" have the same meanings in Table I. Reception east of the Rocky Mountains would not be expected to be improved by a 400 watt station in Hawaii, hence 97% "Same" seems reasonable. The region west of the Rocky Mountains showed a 30% improvement. It is

Table I

Locality	West Coast					Alaska					Pacific Islands				
Freq. Mc.	5	10	15	No.	%	5	10	15	No.	%	5	10	15	No.	%
Better	182	187	124	493	20.0	1708	2044	1993	5745	67.2	549	787	873	2209	87.6
Worse	—	—	—	—	—	11	68	40	119	1.5	—	—	—	—	—
Same	464	798	704	1966	80.0	523	1110	1042	2675	31.3	71	115	128	314	12.4
Totals	646	985	828	2459	—	2242	3222	3075	8539	—	620	902	1001	2523	—

Table II

Locality	East of Rocky Mts.					West of Rocky Mts.					Fort Hase, Oahu, T. H.				
Freq. Mc.	5	10	15	No.	%	5	10	15	No.	%	5	10	15	No.	%
Better	13	23	45	81	2.4	121	125	106	352	29.9	157	86	17	260	54.6
Worse	2	7	8	17	0.6	1	0	1	2	0.2	—	—	—	—	—
Same	1005	1256	953	3214	97.0	215	319	288	822	69.9	27	84	105	216	45.4
Totals	1020	1286	1006	3312	—	337	444	395	1176	—	184	170	122	476	—

rather surprising to find only about 55% improvement at Fort Hase so near to WWVH. The reason appears to be that WWV's 15 MC transmission is of equal or greater intensity than WWVH's.

Data from Adak, Alaska

Monthly reports of reception of WWVH and WWV were received from the U. S. Army's Ionospheric Station at Adak, Alaska, beginning in Nov. 1949. These reports usually gave signal intensity readings for each hour of each day of the month for 5, 10 and 15 MC from WWVH and 20 MC from WWV. The signal intensity was given on a 0-9 basis for each hour, 9 representing the strongest signal, and 0 the weakest. A low monthly average value does not necessarily mean that the received intensity was consistently low for the particular hour or times considered; rather, it may have been zero for many days and high for a few days. The original data show this, but the fact is obscured by taking an average which, however, appears to be the most practical way of presenting the data.

Reception of WWVH on 5 MC at Adak is shown for 12 months in Fig. 1, where signal intensity is plotted for each hour of universal time. Fig. 1 shows that the 5 MC reception is best during the hours of darkness, which are shown shaded in the lower part of the figure. This is an agreement with the well-known absorption effect which makes 5 MC useful only for a few hundred miles during daylight, but useful a few thousand miles at night. The cause of the low values of signal intensity for June and July is not known, but is thought to be an absorption effect.

Reception of WWVH on 10 MC at Adak for 12 months is shown in Fig. 2. It will be noted that for Nov. through Feb. reception is best for a period of a few hours starting a couple of hours before sunset. The curve for March shows an extension in the number of hours to about eleven when reception is useful. Reception in April was useful about 15½ hours. In May reception began about 1½ hours later than in April and dropped off ½ an hour earlier. June, July, Sept. and Oct. showed reception consistently weak and unusable.

Reception of WWVH on 15 MC at Adak for 12 months is shown in Fig. 3. It will be noted that for Nov. through March the hours of reception were approximately those when 5 MC was not received. The curve for April shows a tendency for improved reception during previous silent hours, but reduction in signal intensity after daybreak. The months of May through Aug. showed excellent reception throughout the 24 hours while Sept. and Oct. show a lowering of signal intensity.

Examination of the data given in the three sets of curves for WWVH shows that for almost any hour in the 24, at least one of the three frequencies was heard with an intensity of 3 or higher. Exceptions were poor reception in April for a few hours after sunrise and in Sept. for a few hours before sunrise. Two frequencies were available a large portion of the time, and three frequencies were heard with high intensity part of the time.

Data on the percentage of time the transmissions of WWVH and WWV were at a useful intensity were submitted by the Radio Propagation Field Station, Anchorage, Alaska, for each month from June 1949 through March 1950. The observations were made hourly from 1500 or 1700 UT to 0900 or 1100 on 5, 10 and 15 MC, and varied from 10 to 31 observations per month for each month for each hour. Data for some hours of some months were quite similar, so that mean values were plotted for such times and the curves were appropriately marked. Curves not marked are either average values for the 10-month period or for that portion of the period not covered by other curves.

Unsatisfactory Reception

Fig. 4 shows the 5 MC reception at Anchorage of both WWVH and WWV with times of sunrise and sunset at the three localities plotted for each month. Reception for June appears to have been quite unsatisfactory. WWV came in earlier and with greater intensity than WWVH, as sunset is from 4 to 5½ hours earlier at WWV. It will be noted that beginning with June, reception comes earlier each month through Jan., except for Oct., and then comes later each month. The data for Sept. indicate greater intensity than for the succeeding month so that they do not fall in line with the other data. The curves for 5 MC reception of WWVH are similar to those for

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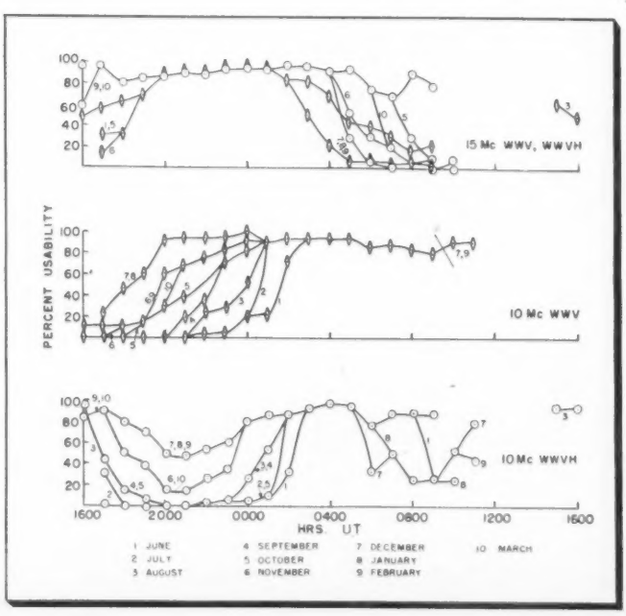


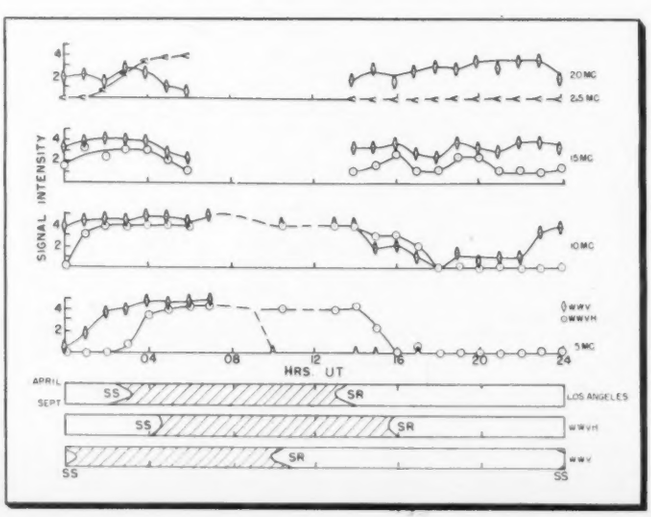


Fig. 5: (L) Reception of WWVH and WWV on 10 and 15 MC at Anchorage, June '49-March '50. Fig. 6: (R) Reception of WWVH and WWV on 5, 10 and 15 MC at Los Angeles, Cal.; WWV on 2.5 and 20 MC, April-Sept. '50.

Ionophone for Audio and Ultrasonics

Unique transducer generates distortionless sound directly from modulated r-f. Applications seen in AM receivers, sonar and dielectric measurement

THE Ionophone sound transducer, invented by Dr. Siegfried Klein of Paris, converts modulated r-f energy directly into distortionless sound without the use of any moving parts. These, and several other unique characteristics, make the device a choice prospect for use in loudspeaker, ultrasonic generator, underwater sound, microphone and pressure measuring applications.

However, further investigation and development will be required before certain performance and constructional limitations can be overcome. The Southwest Research Institute, a non-profit research organization, is presently in the process of studying the device. Affiliated with SRI, the Institute of Inventive Research, P.O. Box 2296, San Antonio 6, Texas, has secured exclusive licensing rights in North America and Japan, and plans to license a select group of manufacturers on a royalty basis. Although not official, royalty rates are reported to range between 3% and 10%, depending on the type of production involved. The rights of this non-profit, administerial foundation (which aids qualified inventors seeking commercial assistance) extend to U.S. Patent 2,524,227 and various patent applications on file or being prepared.

Operation

The mechanism by which sound is generated is based on a series of ion impacts with air molecules which set up a sound pattern determined by the amplitude and frequency of the moving ions. This ion movement is in turn controlled by a modulated r-f voltage which causes the expansion and contraction of the ion cloud created by a heated emitter in a refractory chamber.

Fig. 1 shows the constructional details of the Ionophone. The platinum electrode, about 0.1 in. diameter, is mounted at the origin of a 5 in. exponential quartz tube. A conventional modulated oscillator and r-f transformer applies an r-f potential of 10 to 15 kv at about 400 KC to 30 MC between the outer shield and emitter, in an arrangement similar to Fig. 2.

Through the action of dielectric losses, the temperature in the quartz about the emitter is raised to 1000°K, and a visible corona discharge of about 0.5 in. is obtained. The heat produced by the ions emitted from the platinum wire help to maintain the high temperature. The vacuum chamber in the quartz tube provides the thermal insulation which localizes the high temperature area. It also acts to insulate the charged area electrically. The high temperature in the discharge zone rarifies the air, thereby decreasing the number of air molecules ionized by the ions and electrons which leave the emitter.

It may be interesting to note that the concept of producing sound by a heated wire is not completely new. Edison attempted it in his Thermophone. However, unlike the Ionophone which alters the amplitude of oscillation of charged particles by changing the strength of an r-f field, the Thermophone caused the air surrounding a heated wire to expand and contract apace with changing wire temperature. The high thermal lag in Edison's invention limited it to low audio frequencies.

Low frequency response in the Ionophone is unlimited except as re-

(*Continued on page* 86)

Fig. 1: Ionophone's ion cloud controlled by emitter-to-shield r-f generates frequencies to 40 kc

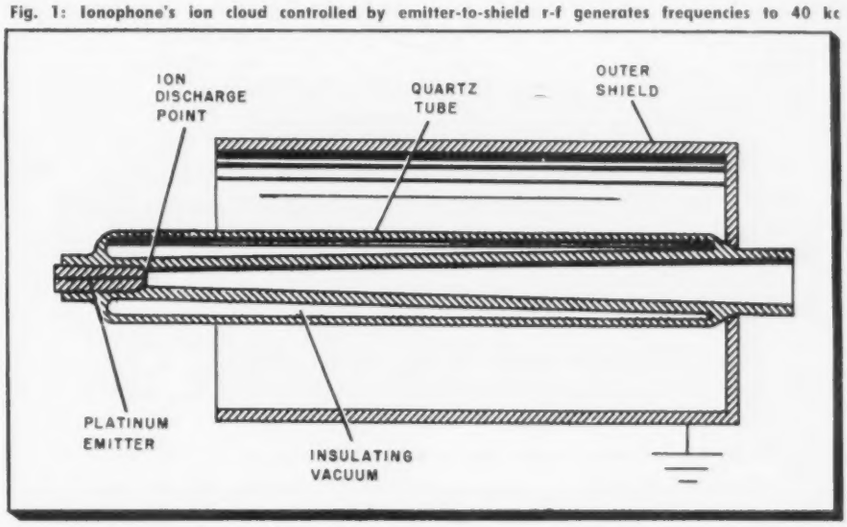
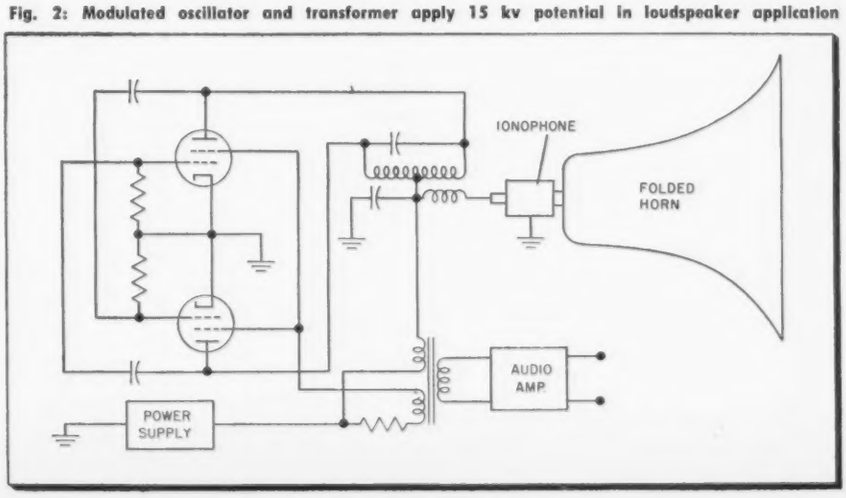


Fig. 2: Modulated oscillator and transformer apply 15 kv potential in loudspeaker application



Modified Magic Tee Phase Shifter

Novel alterations permit device to shift phase independent of load while distance plungers of parallel symmetrical arms linked to common drive and mutually op-

By R. H. REED,
Antenna Section,
Radar Components Dept.
Hughes Aircraft Co.
Culver City, Calif.

MANY microwave measurement techniques require the use of a phase-shifter having waveguide input and output terminals. The ideal phase-shifter should have no losses, should shift phase independently of the load presented, and should have a normalized input impedance of unity. In addition, it is usually desirable that the physical distance between input and output terminals remain constant. This latter requirement is fulfilled by any method in which isolation exists between energy incident on and reflected from a conducting surface, since the phase may then be shifted by moving the surface.

Meeting Requirements

The foregoing requirements are met by a number of balanced duplexers and, in particular, by the magic tee. Fig 1 shows a conventional magic tee with short-circuiting plungers placed in the symmetrical arms (impedance matching devices have been omitted for clarity). Let us assume that energy is fed into the H-plane arm. At the junction, the energy will divide equally and in phase between the symmetrical arms, none of it going into the E-plane arm due to the symmetry of the junction.

If the short-circuiting plungers in Fig. 1 are so placed that

$$l_1 - l_2 = (2n + 1)\lambda_g/4 \qquad (1)$$

where λ_g = waveguide wavelength and $n = 0, \pm 1, \pm 2, \pm 3, \ldots$, the energy reflected from one short circuit will return to the junction 180° out of phase with the energy from the second short circuit and so will couple to the E-plane arm, none being coupled back to the input. Since (1) is the only restriction imposed on the positions of the short circuits, these may be moved equal distances toward or away from the junction, thus changing the electrical path length between the E-plane and H-plane arms, i.e., shifting the relative phase between the output and input terminals. It should be noted here that although (1) holds for all values of n, the condition which is always used is that where $n = 0$ or $n = -1$, since this gives the broadest bandpass.

An analysis of the equivalent circuit of a magic tee junction (Fig. 2) shows that, if reactances jX_1 and jX_2 are placed in the symmetrical arms, the normalized input impedance of the H-plane arm is

$$Z_i = \frac{2 + jZ_1(X_1 + X_2)}{j(X_1 + X_2) - Z_1 Z_2} \qquad (2)$$

where Z_i is the output impedance of the tee.

To satisfy the conditions imposed by (1), it is necessary that

$$X_1 = \tan \beta l \qquad (3a)$$

and

$$X_2 = \tan\left(\beta l + \pi/2\right) = -\cot \beta l. \qquad (3b)$$

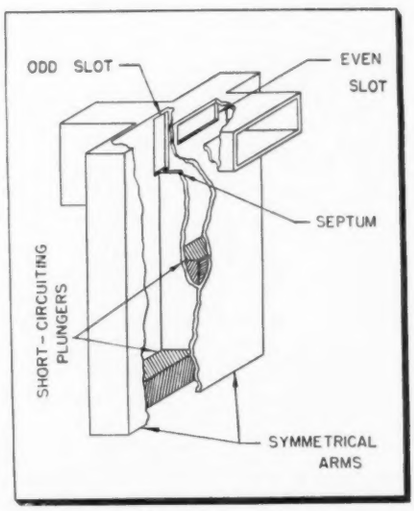


Fig. 3: Modified magic tee symmetrical arms are mutually parallel, linked to common drive

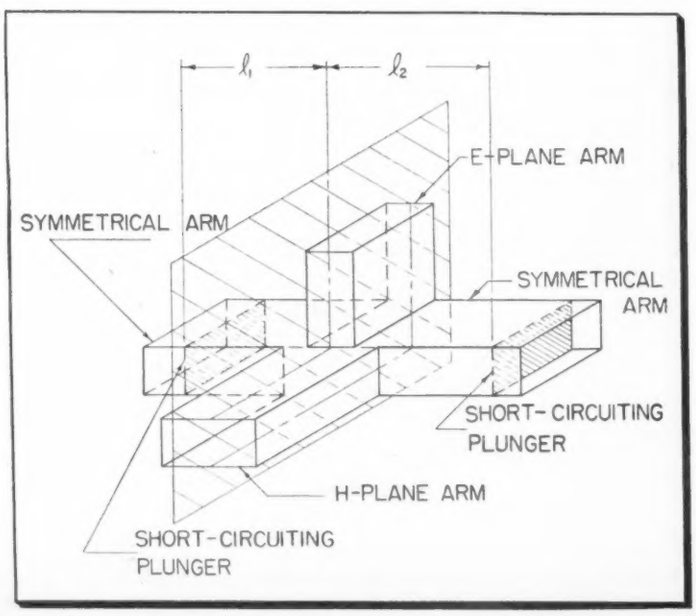
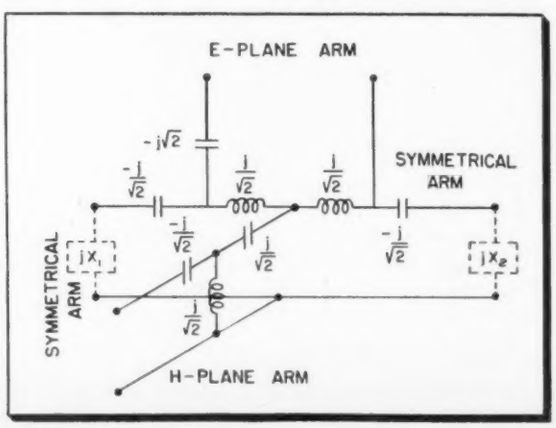


Fig. 1: (L) Conventional magic tee with short-circuiting plungers placed in the symmetrical arms may be used as a phase shifter or impedance transformer. Impedance matching devices are omitted for clarity. Fig. 2: (R) Equivalent circuit of tee



for Microwaves

between terminals remains constant. Shorting posed input and output facilitate measurement

Substituting (3a) and (3b) in (2)

$$Z_i = \frac{Z_L \cos 2\beta l + j \sin 2\beta l}{\cos 2\beta l + j Z_L \sin 2\beta l} \qquad (4)$$

gives
which will be recognized as the expression for the input impedance of a lossless transmission line, with a βl term substituted for βl. The phase-shift is therefore equal to twice the electrical motion of the short circuits.

The magic tee may also be used as an impedance transformer or matching device, simply by adjusting the short-circuiting plungers independently to obtain the desired input impedance. This can be shown from (2). Let $Z_1 = R_1 + jX_1$ and $Z_1 = R_1 + jX_1$. The solution of (2) for X_1 and X_2 is

$$X_1 = \frac{(R_1 X_L - R_L X_1) + \sqrt{R_L R_1 [(R_L - R_1)^2 + (X_L - X_1)^2]}}{2 (R_1 (R_L^2 + X_L^2) - R_L (R_1^2 + X_1^2))} \qquad (4a)$$

and

$$X_2 = \frac{(R_1 X_L - R_L X_1) - \sqrt{R_L R_1 [(R_L - R_1)^2 + (X_L - X_1)^2]}}{2 (R_1 (R_L^2 + X_L^2) - R_L (R_1^2 + X_1^2))} \qquad (4b)$$

These expressions are real for all values of Z_i and Z_l, and therefore are satisfied by $X_1 = \tan \beta l_1$ and $X_2 = \tan \beta l_2$.

Modified Magic Tee

Although satisfactory electrically, the conventional magic tee has a physical configuration which is undesirable for use as a phase-shifter. The input and output terminals are normal to one another rather than being opposed; this makes laboratory use awkward since it requires a change in the direction of energy transmission from horizontal to vertical. The symmetrical arms are opposed rather than in-line, requiring an accurate mechanical linkage between the two short-circuiting plungers.

These difficulties are obviated by the modified magic tee shown in Fig. 3. The modification has the symmetrical arms parallel to each other, allowing both of the short circuits to be linked to a common drive. The E-and H-plane arms are replaced by "odd" and "even" coupling slots which are placed on opposite broad faces of the symmetrical arms. The terms "odd" and "even" are used because the odd slot excites waves which are 180° out of phase in the symmetrical arms (odd symmetry) whereas the even slot excites waves which are in phase in the symmetrical arms (even symmetry).

Centering Coupling Slots

Accurate centering of the coupling slots is essential if both of the symmetrical arms are to be fed equally. Unequal feeding of the symmetrical arms will result in poor isolation between the even and odd slots. The centering problem is especially serious for the odd slot because its narrow dimension is normal to the waveguide axes; the problem is minimized through the use of a wide slot. Use of wide slots also allows a higher power handling capacity. Experimentally it was found that better than 35 db isolation could be obtained between slots 0.197 wavelength wide (0.250 in. at 9330 MC), provided that tolerances of ±0.001 in. were maintained.

As is to be expected, the inputs to the tee present an impedance mis-

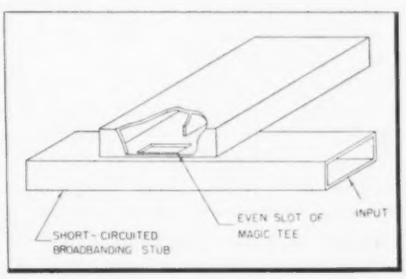


Fig. 4: Matched one-to-two guide transition

match comparable to any one-to-two waveguide junction. The waveguide transition shown in Fig. 4 eliminates the mismatch and has an input vswr under 1.05 over a frequency range of 4%. The correct impedance was obtained by adjusting the position of the coupling slot with respect to the center-line of the waveguide. The short-circuited broadbanding stub is five quarter-wavelengths long. It presents an open-circuit to the coupling slot at the resonant frequency of the slot and cancels the susceptance of the coupling slot at frequencies near resonance.

The transition is applicable only

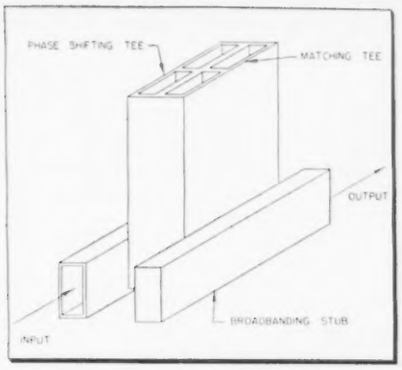


Fig. 5: Complete phase shifter assembly uses a second tee as an impedance matching device

to the even slot of the tee. It is therefore necessary to use two tees, coupled to each other by means of and odd slot, to permit the use of this transition section for both input and output coupling. The second tee is not superfluous since it may be used as an impedance matching device when perfect matching is required. Fig. 5 shows the tees and transitions in a complete assembly.

Alignment

Due to the existence of several sources of impedance mismatch in the above assembly, a special procedure is required to facilitate alignment. Considering the assembly to be fed directly into the phase-shifting tee, the mismatches fall into three groups: 1. Input discontinuities; 2. Misalignment of the phase-shifting short circuits (i.e., Eq. (1) not satisfied); 3. Discontinuities beyond the phase-shifting short circuits (due to odd slot, matching tee and output coupling device).

These three discontinuities can be observed independently for, as the phase-shifting short circuits are moved in electrical degrees, the phase of the reflection coefficient of the first discontinuity remains constant, that of the second rotates n degrees and that of the third rotates 2n degrees.

The total reflection coefficient of two shunt discontinuities, whose reflection coefficients referred to a common point are Γ_1 and Γ_2 respectively, is

$$\Gamma_T = (\Gamma_1 + \Gamma_2 + 2\Gamma_1 \Gamma_2) / (1 - \Gamma_1 \Gamma_2) \qquad (5)$$

If Γ_1 and Γ_2 are small, the product terms may be neglected, so that (2) can be simplified to

$$\Gamma_T = \Gamma_1 + \Gamma_2 \qquad (6)$$

By simple extension of the above argument,

$$\Gamma_T = \Gamma_1 + \Gamma_2 + \Gamma_3 \qquad (7)$$

for three small discontinuities. Let

MODIFIED MAGIC TEE (Continued)

Γ_1, Γ_2 and Γ_3 be the reflection coefficients of the three groups of discontinuities in the phase-shifter assembly. Then, at an arbitrary reference point before the input to the phase-shifter,

$$\Gamma_T = \Gamma_1 + |\Gamma_2| \cos k\phi + |\Gamma_3| \cos 2k\theta + j\,[|\Gamma_2| \sin k\phi + |\Gamma_3| \sin k\theta] \quad (8)$$

where $k = (2\pi\Delta l)/\lambda g$; Δl = motion of short circuits; ϕ = phase of Γ_2 at the reference point; θ = phase of Γ_3 at the reference point.

Changing Phase Angle

The phase angle of Γ_3 changes twice as rapidly as that of Γ_2 (Fig. 6a), so Γ_T will trace the curves of Fig. 6b or 6c, depending on whether Γ_2 is smaller or greater than Γ_3. If $\Gamma_3 = 0$, Γ_T will trace a circle for $\lambda_g/2$ motion of the short circuits; if $\Gamma_2 = 0$, Γ_T will trace a circle for $\lambda_g/4$ motion of the short circuits. The source of misalignment can be determined from the distance that the short circuits must be moved for Γ_T to rotate 360°.

Cascading

The modified form of the magic tee lends itself well to cascading. A linear array antenna may be made by cutting slots in the closed ends of a group of ganged tees; this array will scan if the relative phases between adjacent elements are shifted by equal amounts. Since each tee is only a little over $\lambda_g/4$ wide, alternate tees in the gang can be used as phase-shifters, the rest being used as impedance transformers and broadbanding devices. The even and odd slots will give unity coupling at resonance because they present themselves identically to both the feeding and fed tees.

Broadbanding (see Fig. 7) can be obtained by placing the short circuits of the impedance transformers in such a manner that, away from resonance, the reactances of the even slots, say, transform to reactances which are opposite in sign to the reactances of the odd slots. An important consequence of the use of impedance transformers is that each element can be matched to the transmission line, thus eliminating the high input impedance at broadside which is common to a great many systems using phase-shift scanning techniques. The weight of such an array, exclusive of supports and mechanical devices for moving the short circuits, would be under 0.25 lb. per element. The mechanical linkage would be simple and very light, since the weight of moving short circuits is less than 0.05 lb. per element.

Performance Curve

Fig. 8 is a curve of the performance of the phase-shifter. A straight line has been drawn through the points, showing some deviation from linearity. An expanded plot of these points showed a maximum deviation from linearity of ±2.2°. The attenuation of the entire assembly remains virtually constant at 0.2 db as the shifter is operated. The indication is that most of the losses are due to imperfect short-circuiting plungers and higher order modes about the coupling slots.

At any given frequency the input vswr can be adjusted to 1.03 or better, depending on the degree of cross-coupling between the odd and even slots. Several of the models tested could be adjusted so that the vswr was not measurable with the available equipment (under 1.01).

The modification of the magic tee was suggested by W. G. Sterns, who contributed helpful suggestions, as did N. H. Enenstein and N. A. Begovich.

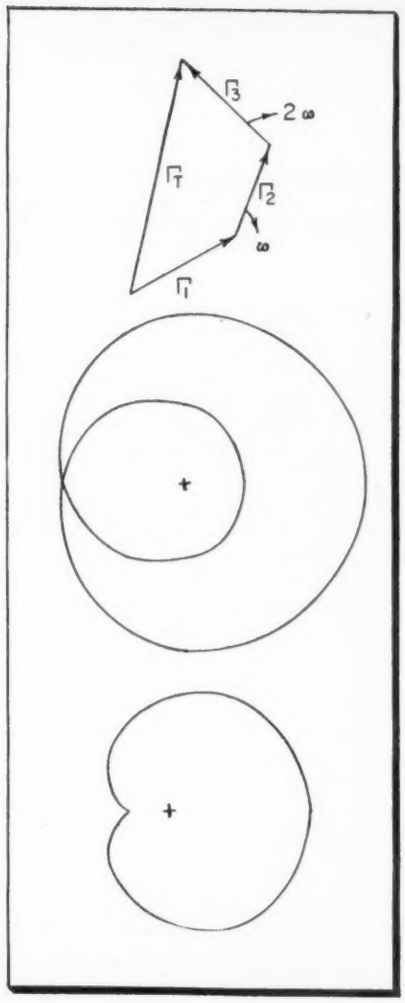
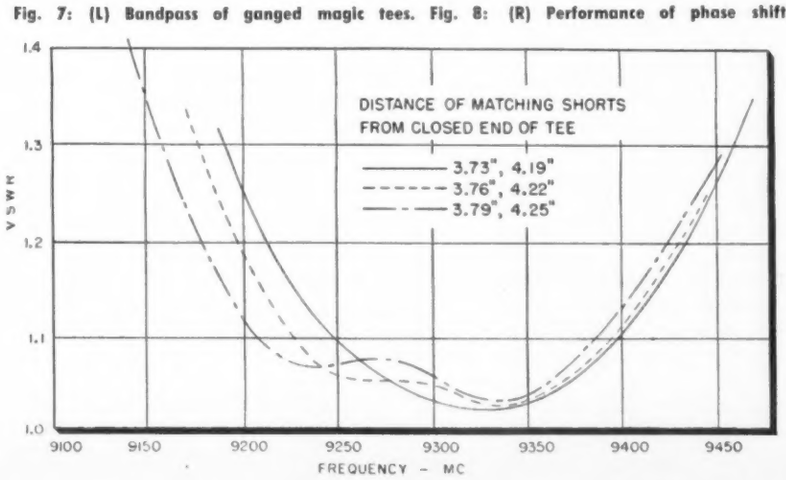
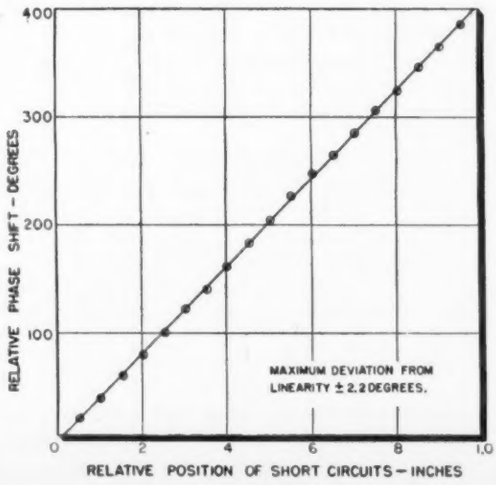


Fig. 6a: (Top) Reflection coefficients due to phase shifter discontinuities. Fig. 6b: (Center) Locus of Γ_T for $\Gamma_2 < \Gamma_3$. Fig. 6c: Locus of Γ_T for $\Gamma_2 > \Gamma_3$

Fig. 7: (L) Bandpass of ganged magic tees. Fig. 8: (R) Performance of phase shifter





New Low-Temperature Capacitors

Electrolytic types for operation to —55° C are highly suitable for use in military equipment. Axial lead aluminum tubular design employed

By J. W. MAXWELL,
Chief Engineer,
Capacitor Div., P. R. Mallory & Co., Inc., Indianapolis 6, Ind.

DURING World War II the capacitor industry was called upon to produce electrolytic capacitors that would give some measure of performance at low temperatures. This was done with the result that eventually a characteristic was written into Specification JAN C62 which covers performance of electrolytic capacitors at temperatures as low as —40°C. Still, however, one problem that confronts the equipment design engineer today is what to do about capacitors rated approximately 4 μf and above at temperatures as low as —55°C., a temperature at which most military equipment must operate.

Where space and weight are not important a well-made paper dielectric capacitor can be relied upon to give proper performance. Unfortunately the majority of equipments being designed for military use can ill afford adequate space and weight required for paper dielectric capacitors. In the interest of saving space and reducing weight, therefore, an electrolytic capacitor design with greatly improved low temperature performance was developed.

The new capacitor element itself is designed along lines similar to the conventional aluminum electrolytic and should not be confused with tantalum types of electrolytic capacitors which also have excellent low temperature characteristics. The excellent low temperature characteristics were made possible through new development techniques in processes and materials.

Ordinary electrolytic capacitors exhibit a considerable capacity drop and a sharply increasing series resistance characteristic with decreasing temperature. This change in capacity, and particularly in resistance, combine to reduce the effective filtering or bypassing ability of the capacitor. At temperatures below —20°C these characteristics start to vary widely and lack sufficient uniformity to guarantee adherence to any restrictive tolerance. While the —40°C capacitor provided a well recognized improvement, the exceptional performance and stability of this new —55°C capacitor is of considerable interest and importance.

In order to eliminate the erratic electrical characteristics that are generally found in electrolytic capacitors at extremely low temperatures, it was necessary to change processing techniques and to select materials of exceptionally high uniformity and purity. The composition and control of the special electrolyte developed for this purpose was a major problem; and, in order to meet the requirements for satisfactory trouble free operation, several new processes involving impregnation and aging the capacitor sections had to be developed and put into practice. The manufacture of these capacitors required many more inspection points during production than normally are encountered in JAN C62 and other high quality types. Also, it was found that a certain physical

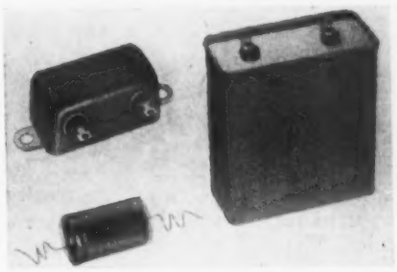


Fig. 1 Low-temperature (to —55° C) electrolytic capacitors feature aluminum tubular design

shape and construction lent itself best to the particular kind of processing necessary to manufacture these capacitors. The basic construction used is the axial lead aluminum tubular design which can easily be assembled singly or in multiple in bathtub or larger rectangular outer cases for hermetically sealed operation. Figure 1 shows typical physical details of these capacitors.

Electrical Characteristics

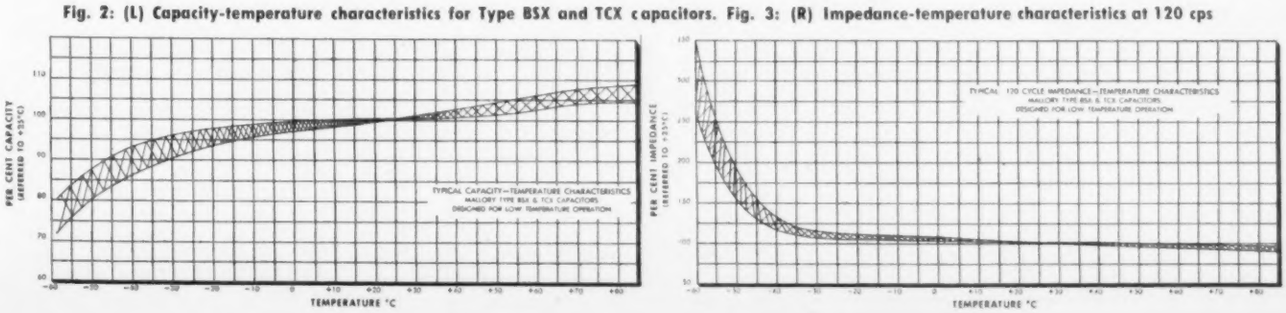
As stated previously, this special low temperature capacitor was developed primarily for performance at extreme low temperatures. While the curves shown in Fig. 2 and Fig. 3 show capacity and impedance variation between —55°C and +85°C the top continuous temperature at full voltage rating should not exceed +65°C., the same as characteristic F of JAN C62. Some loss in low

(*Continued on page* 138)

ELECTRICAL MEASUREMENTS (120 cycle)

Capacitor Number	Initial Cap.	Initial ESR	After Storage Cap.	After Storage ESR
1	28.5 μf	1.4 ohms	27 μf	1.11 ohms
4	34 μf	1.18 ohms	36 μf	.84 ohms

Fig. 2: (L) Capacity-temperature characteristics for Type BSX and TCX capacitors. Fig. 3: (R) Impedance-temperature characteristics at 120 cps


PER CENT CAPACITY
TYPICAL CAPACITY—TEMPERATURE CHARACTERISTICS
MALLORY TYPE BSX & TCX CAPACITORS
DESIGNED FOR LOW TEMPERATURE OPERATION
TEMPERATURE °C
PER CENT IMPEDANCE
TYPICAL 120 CYCLE IMPEDANCE—TEMPERATURE CHARACTERISTICS
MALLORY TYPE BSX & TCX CAPACITORS
DESIGNED FOR LOW TEMPERATURE OPERATION
TEMPERATURE °C

CUES for BROADCASTERS

Practical ways of improving station operation and efficiency

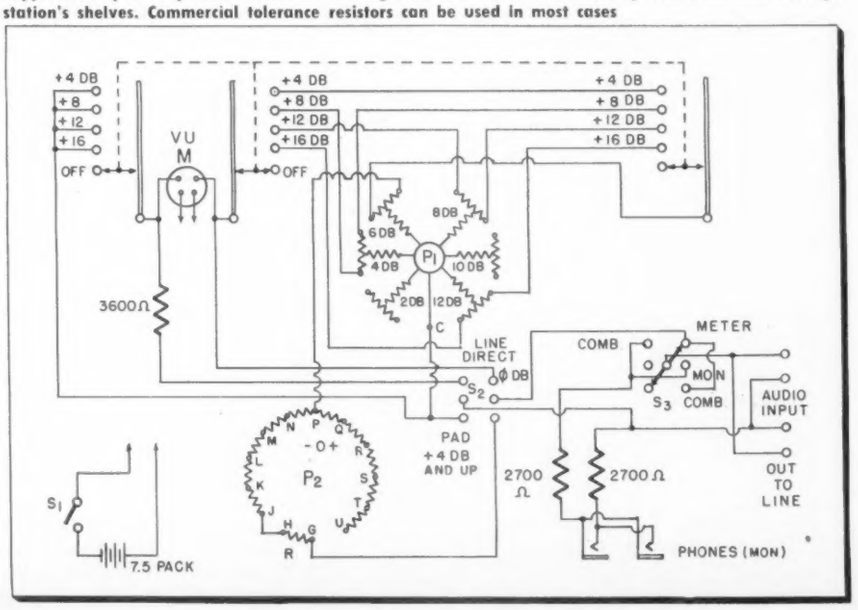
Extra & Portable Volume (VU) Indicating Source

JEFF EVANS, Chief Engineer, WLDY, Ladysmith, Wis.

QUITE often, limited budgets make it desirable to have a portable, and/or extra VU indicating source. Most small stations have a spare VU meter; the old type, or a new one which would normally be used for replacement in the consoles. The following circuit can be made up of spare parts or pads bought through regular channels. An army surplus power output meter case was used for mounting the meter and associated switches.

The circuit can be inserted across the line for broadcast without any effect on the line. At WLDY, the meter is usually on top of two Eicor tape recorders, rack mounted as an indicating device for recording. The meter usually indicates the output of program amplifier No. 2 which feeds the tape recorders. When necessary, the meter can be instantly unplugged from amplifier No. 2, the top put on the case and taken on a remote. In the event the station does not wish to invest in the matching pad P2 (which is calibrated in 0.1 db steps) the pad can be omitted but the 3600 ohm resistor must be used. The schematic shows that the meter can be either after the attenuator pad, or directly across the line, for low levels. P1 can be any attenuator pad, calibrated in 2 db steps—if 4 db steps are not preferred—or when it is known that the signal will never go above 4 db both pads can be left out entirely and a T pad looking at 3900 ohms in either direction inserted. This pad can be made of resistors where value is determined by any pad chart.

Supplementary and portable VU meter using standard stock items usually found on the average station's shelves. Commercial tolerance resistors can be used in most cases



$$$ FOR YOUR IDEAS

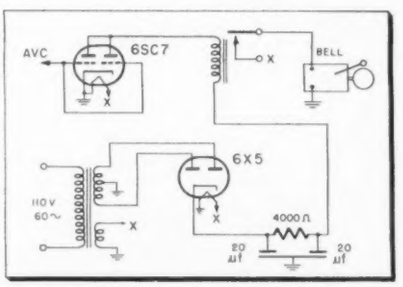
Readers are invited to contribute their own suggestions which should be short and include photographs or rough sketches. Typewritten, double-spaced text is preferred. Our usual rates will be paid for material used.

Low Cost Automatic Conelrad Warning

CHARLES E. VEAZIE, WASA, Havre de Grace, Md.

SOME stations may not be using an automatic alarm device for Operation Conelrad, due to the expense of devices triggered by the 1000 cycle tone. WASA is using a foolproof device which costs less than $10.

Power supply is taken from a discarded receiver. A 6SC7 tube, with grid and plates connected in parallel, has a Potter Brumfield 10,000 ohm plate circuit relay as its plate load. This tube is biased beyond cut-off by AVC voltage developed by the Conelrad receiver. The audible alarm, a doorbell mounted on the same chassis, is powered by the filament supply. The audio output of the receiver is brought to a speaker in the control room, which is normally cut off. If the bell rings, the operator turns on the speaker; thus this device also warns of any failure of the receiver or the key station.



Values in this Conelrad warning circuit are not critical. Relay adjustment covers most operating conditions encountered

Cueing Broadcast Discs

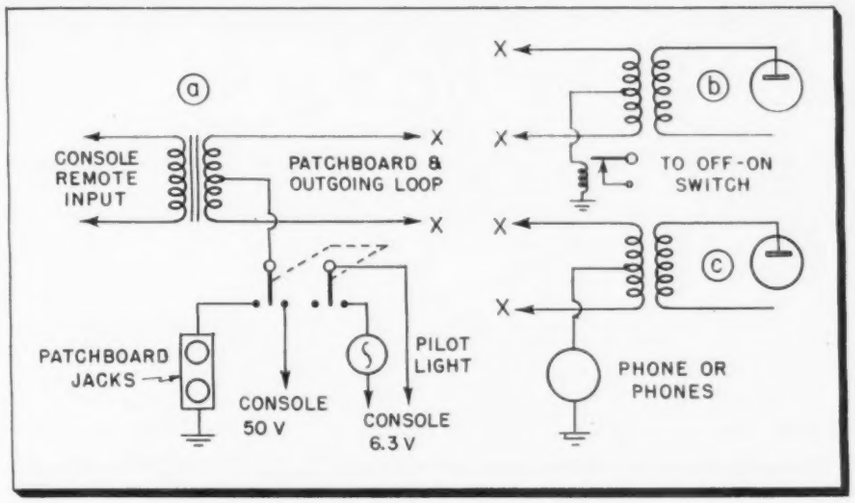
FRANK COOK, 1002 Eighth St. South, Moorhead, Minn.

TO assist in cueing broadcast discs that have very little land between cuts, place an arrow made of splicing tape on the face of the pick-up pointing to the first groove of the cut. Do this when the needle is in the first groove. After the arrow is once in place it is an easy matter to place the pick-up in the first groove for cueing.

Simplex Operation of Order Phone and Remote Amplifiers

ELLIOTT FULL, Chief Engineer, KXIC, Iowa City, Iowa

FOR several years, KXIC has been operating two permanent church remote installations from our control room by simplexing 50 v. on the interconnecting loops. The amplifiers have a high resistance



Simplex operation of properly balanced telephone line enables engineers to talk back over remote lines which are on the air without risk of broadcasting crosstalk

(2 ma) relay connected between the output transformer secondaries' center tap and ground. The contact points parallel the on-off switch.

Recently, we found it necessary to talk to several sporting event remotes while the remotes were on the air. As can be seen from the diagram, the other pole on the simplexing switch, (the off position), was brought out to a jack on the patch panel. A local battery phone, such as many stations use for intercom with their transmitter, is used to talk to the phone or earphones connected (c) to the remote amplifier.

We have had a simplexed telephone on the broadcast line to KXIC's Farm Editor's farm for several years. We have not experienced any cross talk on any simplexed lines. However, it is recommended that a loop to be simplexed be checked in advance as an unbalanced simplexed loop will give cross talk.

Grounding for Rack-Mounted Equipment

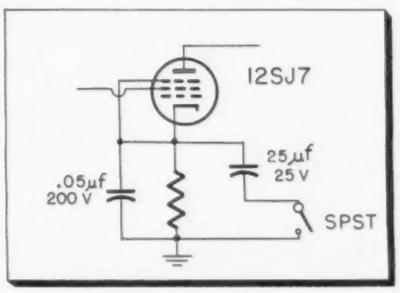
EDWIN W. HILL,
WCAU-TV, Philadelphia, Pa.

DEVISING an electrically-efficient, rugged, neat and convenient method of grounding the various components in a rack full of broadcast equipment always poses a problem. One effective solution involves the use of a piece of copper grounding strip, 1 to 1½ in. wide. It is run the full height of the rack on the inside, bolted where convenient, and grounded firmly to the base of the rack. Copper strip, such as this, provides a very low resistance ground; but has the drawback of being difficult to solder. However, soldering connecting wires to the strip is simplified by drilling a row of small holes, spaced, say, ⅜ in. along one edge of the strip. The connecting wires can then be attached to the holes and soldered easily.

Tape Recorder Equalization

T. A. HILDEBRAND, Chief Engineer, KBMY, Billings, Montana

SPEECH and music quality of network programs often lacks clarity due to loss of the higher frequencies. This is usually caused by poor delay recordings, or insufficient line equalization. Restoration of program material has been accomplished by a simple modification of our Magnecorders to provide a slight high boost as shown in the schematic. This change causes loss of 7 db at 1000 cps, which can be eliminated by a slight advance of the gain control. The SPST switch is mounted on the front panel of the PT6-J amplifier—where the high boost can be easily and quickly controlled. When recording a net program, the circuit provides a 3.5 db boost at 3500 cps with a 5 db boost at 5000 cps. On playback, the equalizer is left in the playback circuit, producing a total rise of 7 db at 3500 cps, and 10 db at 5000 cps. Where the PT6-J amplifier is used as a remote pickup amplifier, the high boost circuit can be used to overcome the losses in telephone lines, which normally require line equalizers.



Second audio stage of PT6-J amplifier modified to provide slight treble boost

Remote Pickup Without Amplifiers

R. S. HOUSTON, Chief Engineer, KNBZ, La Junta, Colo.

MANY times there is need for a hurried pickup of a narrative nature, such as a parade, or one-shot sports pickup where there is difficulty getting power, and no battery amplifiers are on hand. In this case, an F1 telephone transmitter, or other type of good quality carbon microphone can be put to good use for speech work.

The input impedance of most consoles is 500 ohms—to match a telephone line. This approximates the impedance of a carbon mike. Any mismatch will be slight, and can be tolerated. To provide button current for the mike, a single #6 dry cell will suffice, on most lines. Connect it in series with the line coming in to the console or repeating coil. The level will be just about right with this much voltage applied. Use the current specified by the manufacturer, if in doubt, or if the volume seems too low. A telephone mike generally uses about 40 mils.

To improve the quality somewhat, and to filter out any internal battery disturbance, a 2μf paper capacitor may be placed across the battery terminals. Cue may be fed to the line in the normal manner, and phones may be used across the mike at the remote end. Crystal phones are advisable, since they are more sensitive, and will not upset the circuit as much as dynamic phones. The voltage used is not sufficient to cause damage, so they may be connected across the line directly.

Programming from Transmitter

JIM HOFFSWELL, Chief Engineer, WLBK, DeKalb, Ill.

DURING the course of the broadcast day, several programs originate at the WLBK transmitter. It became necessary to provide suitable facilities for this operation and also conveniently switch to the studio. This was accomplished by installing a "super-

(*Continued on page* 72)

Tape Recording for Telemetry & Data

Multi-track tapes find applications in studies of guided missiles, aircraft shock and vibration tests, and computers. Recent innovations sharply

By KENNETH B. BOOTHE,
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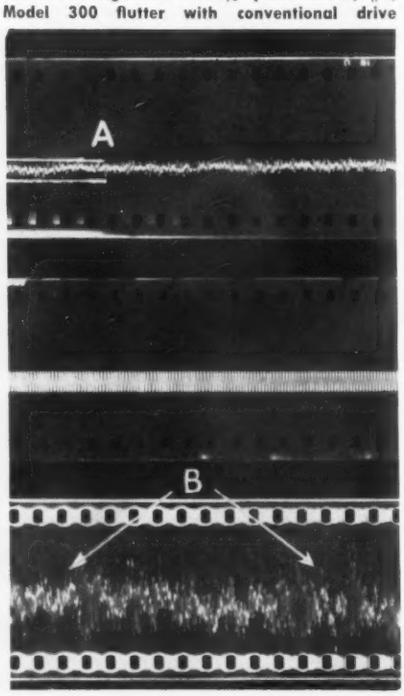
ANOTHER complicating factor is introduced by nodules or surface irregularities in tape coating material which have somewhat the same effect on tape that resin has on a violin string. While tape is in motion, nodules or surface imperfections strike the heads setting up a series of damped oscillations. Surprisingly enough, these flutter frequencies may occur at approximately 3,000 cycles, or well beyond the frequency range of the conventional flutter bridges.

Minnesota Mining has been cooperative in making available special tapes which have been preselected for telemetering and other instrumentation uses. They are relatively nodule free and are a great improvement over standard recording tapes.

Ampex has employed special equipment which provides a complete and comprehensive flutter analysis for magnetic tape recorders.

Fig. 8: Oscilloscope recordings (top to bottom): Record #1, Model 500 wow and flutters; #2, calibration signal of 0.04% peak flutter; #3, Model 300 flutter with conventional drive



An unmodulated 15 KC tone was first recorded on the Model 500 and then played back through a limiter and an FM discriminator having an information frequency response of ±1 db from 0 to 4,000 cycles. By connecting an oscilloscope to the output of the discriminator, resulting traces were photographed with a special moving film camera operating at a film speed of 28.4 ips. Since any flutter in the tape drive mechanism will FM the 15 KC tone during the record and playback process, a corresponding amplitude change will occur at the discriminator output or across the deflecting plates of the oscillograph. Therefore, amplitude changes in the oscillographic traces may be photographed and accurately measured to determine actual peak-to-peak wow and flutter in the recorder over a frequency range of from 0 to 4,000 cycles. Record #1 of Fig. 8 is a photograph of the actual Model 500 wow and flutter products.

Record #2 is a calibration signal corresponding to an amplitude of 0.04% peak-to-peak flutter which was the same calibration used for all records. This figure was determined by measuring the voltage vs. frequency characteristics of the discriminator, and applying a voltage to the measuring plates of the oscilloscope corresponding to a peak-to-peak deflection of a 0.04% flutter.

Record #3 was made by recording a 15 KC tone on a standard Ampex Model 300 sound recorder using non-selected ¼-in. tape. Employing the same flutter measuring techniques as before, this particular record which represents approximately 0.24% peak-to-peak flutter was chosen to illustrate some of the wow and flutter difficulties with conventional drive systems. Although such mechanical irregularities are too small to be objectionable in sound recording or in a number of instrumentation applications, they can be a serious problem in precision FM-FM telemetering.

Typical 3000 cycle damped wave oscillations may be clearly seen at points "B." But, due to the aforementioned new principles in the Model 500 tape drive mechanism, this type of flutter does not occur. This fact may be illustrated as follows:

Record #1 was made from ½ in., non-selected tape, and represents the worst condition that could be found after making a series of test recordings. Record #2 shows the previously mentioned flutter calibration reference which has been accurately measured at 0.04% peak-to-peak.

Record #1 shows peak-to-peak flutter to be well under 0.05% except for occasional spikes caused by tape nodules. These spikes at point "A" correspond to a maximum of 0.052% peak-to-peak and are well within the most exacting telemetering requirements. With the Model 500, it is of great significance that the presence of one nodule causes an instantaneous modulation in the recorded tone which lasts for only one cycle, or for the exact period required for the nodule to pass over the head. With the drive system of the standard Model 300 audio frequency recorder, however, it may be seen that one tape nodule produces a damped oscillation of high amplitude and long duration as shown at points "B."

JAN Specifications

The Model 500 is built in general accordance with JAN and Navy Dept. 16-E-4 specifications. It is a dual speed recorder and includes four separate recording and playback channels of plug-in construction. At a tape speed of 60 ips, each channel will record and reproduce within ±3 db from 200 to 80,000 cycles. Thus three separate channels containing all Research and Development Board approved subcarriers, plus a timing and tape speed control channel, can be recorded simultaneously on one machine. Plug-in amplifier construction has been employed for easy maintenance and to provide greater flexibility for modifications which may develop at some later date.

The 500 also includes the new Ampex Model 381 Speed-Lock system. Speed-Lock compensates dc

Analysis

PART TWO OF TWO PARTS

and vehicular operation, reduce wow and flutter

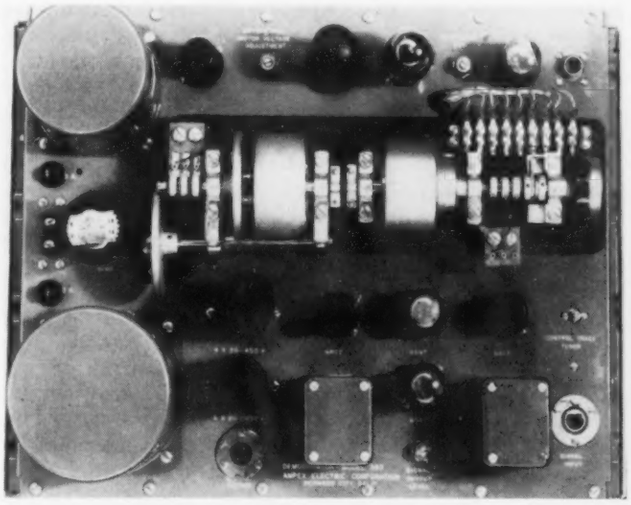


Fig. 9: Demodulator and differential playback chassis, part of Speed-Lock system which compensates for changes in tape dimensions

errors due to tape stretch and dimensional changes produced by humidity and temperature variations. Therefore, playback speed will be automatically adjusted to insure against any difference in playback frequency vs. recorded frequency. Correction accuracy is within 1 millisecond throughout the entire reel of tape. Ampex Speed-Lock may also be used with Models 302 and 307 telemetering recorders without circuit modifications.

Fig. 9 shows the demodulator and differential playback chassis, part of the Speed-Lock system.

Investigations carried on at several test centers indicate that as much as 5% telemetering error can be caused by tape stretch. Since telemetering stations usually operate under the most unfavorable climatic conditions, Speed-Lock can be an important accessory in maintaining accurate data storage.

Fig. 10 pictures the laboratory signal analysis reproducer Model S-3037. It has a three-speed drive and eight-track reproduction on the horizontal table. The vertical table provides re-recording and loop operation.

The head assembly of the Model 500 is illustrated in Fig. 11. Note the large capstan which is perforated for a vacuum type suction which holds the tape in contact.

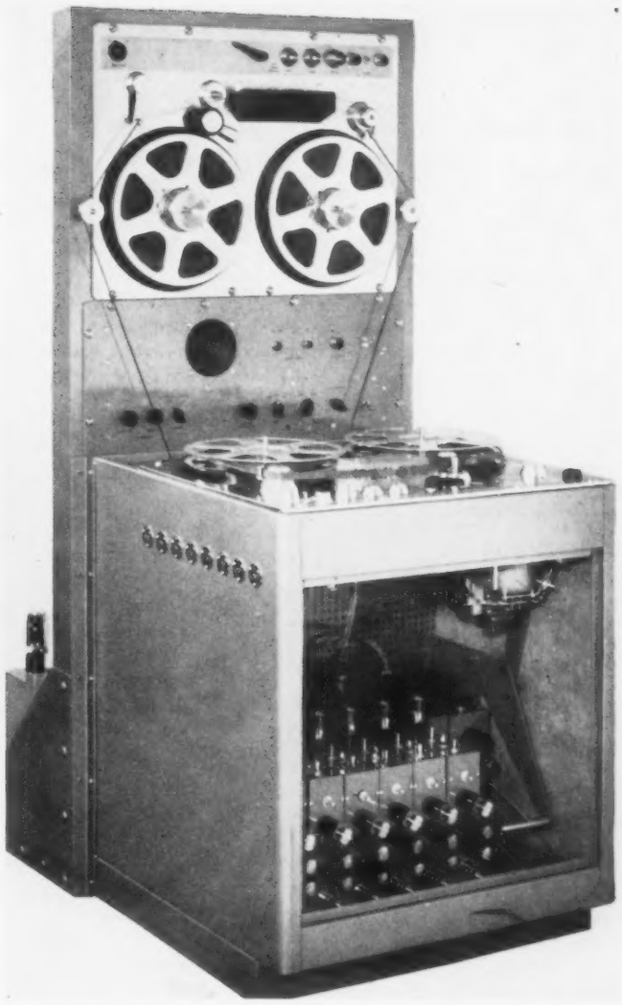


Fig. 10: Model S-3037 has three-speed drive, records eight tracks. Vertical table provides re-recording on two tracks, loop operation

A completely new technique has been recently developed by Ampex and Douglas Aircraft engineers for recording pulse width modulation (PWM) data on tape. This system is primarily used in telemetering but it may also be applied to low frequency shock and vibration recording. The main advantage of PWM recording is the phenomenal accuracy which can be consistently maintained. This accuracy is affected very little by wow and flutter which means that the recorder does not require flutter compensation.

PWM may be described as having the leading edge of the pulse fixed in time sequence while the trailing edge varies in accordance with the information. Therefore, instantaneous information values are contained within the instantaneous widths of pulses which are proportional to the percent of modulation.

If PWM information were to be recorded directly on magnetic tape, the reproduced pulses would become extremely distorted due to the rapid rise time of the pulses and the limited bandpass of the recorder. Therefore, it is necessary first to convert the leading and trailing edges to sharp spikes before recording them on tape. On playback, these spikes are reproduced and are reconverted to pulses by means of suitable reshaping circuits. This recorder, Model 303, includes all required circuitry for recording and reproducing PWM signals within ± 2 μsec of pulses which are from 100 to 1000 μsec in width. This accuracy is achieved at a tape speed of 30 ips. For added flexibility, the Model S-3084 dual-track recorder was developed so that FM-FM data may be recorded on one track while PWM information is recorded on the other.

Wave Shape Preserved

Many types of special recorders, single and multi-track, have been developed for shock and vibration studies and other related applications. However, they usually have one requirement in common. Namely, a frequency response that accurately preserves wave shape down to dc or several cycles per second. High frequency response, however, may be

(*Continued on page* 90)

Lightning Protection

Common grounds, parallel conducting paths, and damage from high current surges. Protection of

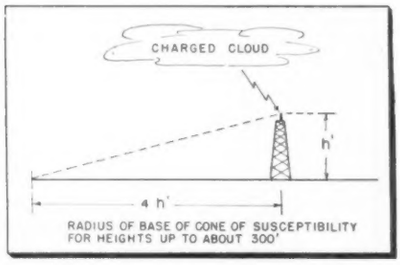


Fig. 1: Probable annual incidence of lightning strokes (I) to a radio tower. Computation: I = Annual no. thunderstorm days (D) × Stroke factor (S) x Susceptible area (A). Example: D = 35, S = 0.28, h = 250 ft., A = 16πh² = 0.113 sq. mi. I = 35 x 0.28 x 0.113 = 1.1 strokes.

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EQUIPMENT in fixed stations of a mobile radio system is susceptible to damage from lightning strokes to either the antennas or the connecting power and land communication facilities unless special protection is provided. The problem, however, is not alone one of protecting the station equipment but consideration must also be given to the protection of the connecting facilities to insure their continuity of service.

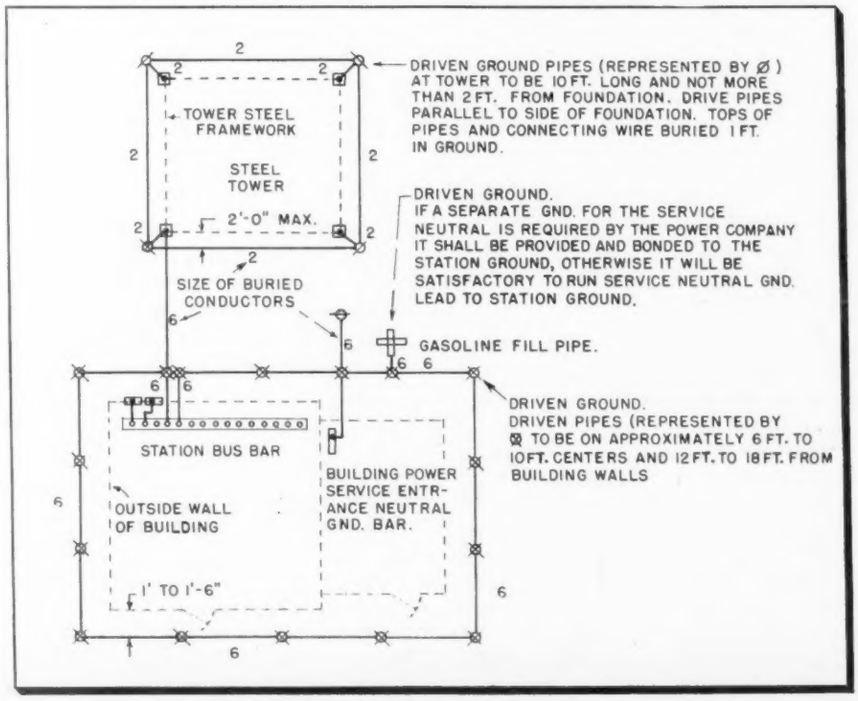
Fixed stations located in rural areas present a more difficult lightning protection problem than the urban installations, but the protection practices employed in each case are basically the same. Stations in sparsely settled areas are generally more exposed not only to strokes to the antennas but also to destructive surges that enter the station equipment and tower lighting circuits from the connecting power and communication facilities. These connecting facilities are usually of aerial construction and as a rule are not as well grounded as in more built-up sections. In urban areas several factors tend to reduce the incidence of lightning trouble such as other high structures that divert strokes from the antenna, and water mains, gas pipes and other underground metallic structures which provide good station grounding. The connecting facilities in urban areas are frequently underground and have adequate conductivity to dissipate heavy stroke currents.

Lightning Damage

Lightning strokes directly to antennas are not uncommon. The grounded structure type of antenna does not require protection, but with the coaxial type a discharge gap between the "whip" and the "skirt," or some form of ¼ wave shorting stub connected to the coaxial lead-in close to the base of the antenna, should be provided to prevent arcing between the inner and outer conductors. Such a shorted stub, tuned to ¼ of the wavelength of the station's operating frequency, will not attenuate normal transmission appreciably, but will introduce a considerable loss to spurious signals such as lightning surges. The coaxial lead-ins commonly used on poles and towers have relatively high dielectric strength. Therefore, arcing is more likely to occur at the equipment end of the lead-in in the patching line or in radio equipment.

For example, ⅜ in. diameter air dielectric line has the lowest breakdown strength of the lines customarily used and will withstand a surge potential of about 7000 peak. The ⅞ in. diameter line and the solid dielectric lines will withstand materially higher voltages. A discharge gap in the antenna will divert a large portion of the stroke current to the coaxial "outer" and the voltage between the inner and outer conductors at the antenna will be that of the arc drop in the gap. However, as the current flows down the outer conductor to ground, the gap drop is supplemented by another potential that builds up between the inner and outer conductors. This voltage is approximately equal to the product of the resistance of the coaxial outer and the surge current flowing in it and is maximum at the terminal end of the line. When the coaxial outer is paralleled by other conducting paths such as a metallic tower structure or a wire when the line is supported on a wooden pole, the combined conductivity is usually enough to hold the voltage between the inner and outer conductors to

Fig. 2: Station grounding arrangement used by Bell System for one-story building with separate tower


DRIVEN GROUND PIPES (REPRESENTED BY Ø) AT TOWER TO BE 10 FT. LONG AND NOT MORE THAN 2 FT. FROM FOUNDATION. DRIVE PIPES PARALLEL TO SIDE OF FOUNDATION. TOPS OF PIPES AND CONNECTING WIRE BURIED 1 FT. IN GROUND.
TOWER STEEL FRAMEWORK
STEEL TOWER
2'-0" MAX.
DRIVEN GROUND. IF A SEPARATE GND. FOR THE SERVICE NEUTRAL IS REQUIRED BY THE POWER COMPANY IT SHALL BE PROVIDED AND BONDED TO THE STATION GROUND, OTHERWISE IT WILL BE SATISFACTORY TO RUN SERVICE NEUTRAL GND. LEAD TO STATION GROUND.
SIZE OF BURIED CONDUCTORS
GASOLINE FILL PIPE.
DRIVEN GROUND. DRIVEN PIPES (REPRESENTED BY ⊠ TO BE ON APPROXIMATELY 6 FT. TO 10 FT. CENTERS AND 12 FT. TO 18 FT. FROM BUILDING WALLS
STATION BUS BAR
BUILDING POWER SERVICE ENTRANCE NEUTRAL GND. BAR.
OUTSIDE WALL OF BUILDING
1' TO 1'-6"

for Fixed Radio Stations

discharge gaps provide three important means for avoiding equipment connecting facilities must also be considered to preserve continuity of service

below the breakdown strength of the line and the connected equipment.

In addition to the problem of dielectric failure, stroke currents subject coaxial lines to magnetic forces directed radially inward which tend to crush the line. The likelihood of crushing may be substantially reduced by providing parallel conducting paths as discussed later, thereby reducing the current in the coaxial "outer."

Surge voltages may also appear between the conductors and conduit of the tower lighting circuit by virtue of stroke current in the conduit. However, it is unlikely that insulation breakdown or lamp damage will occur except on very large stroke currents because of the conductivity of the metallic conduit and other conducting paths in parallel with it.

Sizeable surge currents in the antenna structure may result from a stroke to ground relatively close to the tower. However, the resultant voltage will, in general, be of lower magnitude than those caused by direct strokes to the antenna or tower and do not constitute a serious protection problem.

Exposure to Direct Strokes

Strokes directly to the station grounding system are unlikely for the buried wire of the grounding system will usually be within the cone of protection of the tower.

The power and communication facilities serving stations in rural areas are usually exposed to direct lightning strokes and also to lightning surges from the rise-in-potential of grounds at other points on the systems such as in customers premises, flash over from guys, etc. Field investigations have established that surges of such origin may damage station equipment and tower lighting. Since rural power lines are generally not as well grounded as urban lines and also the communication circuits may be more exposed, these facilities in themselves present a considerable protection problem to insure continuity of service.

The results of recent field measurements indicate that the annual

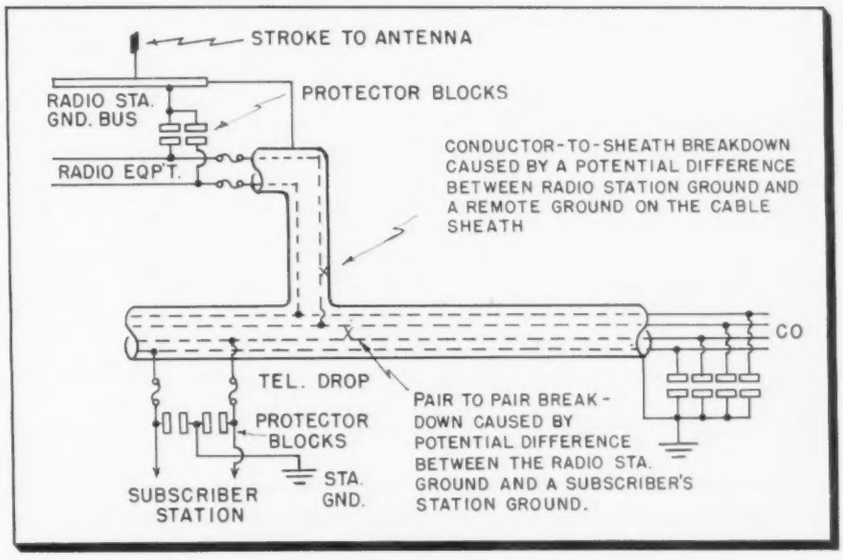

STROKE TO ANTENNA
RADIO STA. GND. BUS
PROTECTOR BLOCKS
RADIO EQP'T.
CONDUCTOR-TO-SHEATH BREAKDOWN CAUSED BY A POTENTIAL DIFFERENCE BETWEEN RADIO STATION GROUND AND A REMOTE GROUND ON THE CABLE SHEATH
CO
TEL. DROP
PROTECTOR BLOCKS
PAIR TO PAIR BREAK-DOWN CAUSED BY POTENTIAL DIFFERENCE BETWEEN THE RADIO STA. GROUND AND A SUBSCRIBER'S STATION GROUND.
STA. GND.
SUBSCRIBER STATION

Fig. 3: Failure in telephone cables serving radio station with standard lightning protection only

incidence of strokes to ground is about 9/sq. mi. in areas having 30 to 35 thunderstorm days per year as shown on an Alexander isoceraunic map. In areas having 50 to 60 thunderstorm days annually the incidence of strokes to ground is in the order of 20/sq. mi. A radio antenna, however, is not just an exposed point, but is susceptible to strokes that would normally strike the earth within a considerable area around it. The probable annual rate of strokes to a radio antenna 250 ft. high in an area having 35 thunderstorm days annually is in the order of one stroke per year (Fig. 1). This approximation is based on the assumption that there are no objects such as tall buildings, trees or power lines projecting through the cone of protection of the tower. The presence of such projecting objects will divert strokes from the tower and lower its stroke incidence. Because a tower is located on a hill it may not necessarily have a higher stroke incidence, especially if there are other hills in the vicinity; however, the stroke incidence may be somewhat higher if it is on an isolated hill or the approach of the storms is over lower altitude terrain.

Magnetic link measurements secured during a period of approximately two years on a 250 ft. metal antenna tower located in an area having 40 thunderstorm days per year indicate that the tower sustained four direct strokes. The following table gives the magnitude of stroke currents recorded:

Measuring Period	Peak Amp. to Gnd. Tower	Coax. Line
July-Dec. '49	9100	200
Jan.-Dec. '50	7700	1900
Jan.-Dec. '50	38000	6000
Jan.-Aug. '51	19000	200

During the period of these measurements it appears that the incidence of strokes to the tower was between one and two per year, which is in good agreement with the theoretical case previously discussed. In a period of one year the station was off the air several times during lightning storms because of tube filament damage and operation of fuses in the radio power supply circuits. Coincident with failure of radio equipment, lamps in the tower lighting burned out and the commercial power line serving the station was disabled on several occasions for periods ranging from 20 min. to 12 hours. Since the instances of station trouble exceeded the number of direct strokes to the tower, it appears that some lightning surges entered the station over the connecting facilities. After some modi-

fication of the existing protection and the addition of arresters on the branch circuits, lightning troubles at this station are no longer a problem.

Protection Methods

The following protection methods have been successfully employed in the protection of land based stations:

1. Apply common grounding to all equipment, metallic structural members and facilities entering a station.
2. Provide a discharge gap in the antenna or a ¼ wave shorting stub in the coaxial lead-in cable close to the antenna.
3. Provide a conducting path in parallel with the coaxial line to reduce voltage between inner and outer conductors.
4. Install lightning arresters on the secondary service leads and lower voltage protectors on branch circuits feeding electronic equipment.
5. Provide discharge gaps on the communication circuits to equalize potentials and conduct surge currents to ground. In cable areas when conditions are severe, additional protection may be secured through the use of higher dielectric cable or conductors in parallel with the cable sheath.
6. For stations without standby facilities install adequate power line protection to help insure continuity of service.

Public metallic water pipes provide adequate grounding from a protection standpoint, but in locations where this means of grounding is not available it is necessary to construct a station ground system. Experience indicates that when setting up the requirements for a "made" ground it is preferable to specify only the dimensions of the buried network and its general configuration rather than its resistance value. Because of the wide variations in soil conditions, the cost of securing a ground of specified resistance may be unduly high and the money can be more profitably spent on supplementary protection on the connecting power and telephone lines.

Common grounding will reduce potential differences between the various metal components of the station. It is well therefore to provide a station ground bus to facilitate the common grounding of such things as the arresters on the power and communication circuits, the outer conductors of coaxial lines, conduit, equipment cases, gas and oil pipes, plumbing and metallic members of the building structure. The antenna tower, if metal, should be connected to the station ground. The tower conduit and coaxial cable outer conductor should be securely bonded to the tower at the top and bottom and also at frequent intervals in a manner to provide good electrical connection. Fig. 2 shows a characteristic station grounding arrangement employed by the Bell System.

Some antennas have incorporated in their design a star shaped discharge gap having an operating value of about 4000 peak v. to prevent flash-over in the coaxial line and connected circuits. A star gap has proven to be an effective protection device. However, it appears that in some recent antenna designs employing multiple arrays, the star gaps are being omitted because of mechanical complications. This makes it necessary to substitute other methods of protection such as the ¼ wavelength shorting stub installed at the base of the antenna. Surge measurements using a 52 ohm solid dielectric line and a current wave of 6 x 15 μsec (peak current attained in 6 μsec, decaying to ½ peak value in 15 μsec) indicate that a ¼ wavelength shorting stub is a satisfactory alternative. The following table gives a comparison of the residual voltage across the load termination for various surge currents applied to the antenna whip.

Surge Current Pk Amp.	Without Gap or Stub	With Gap	With 11 in. Stub	With 55 in. Stub
1000	9000	190	240	310
5000	*	800	1200	1550
10000	*	1600	2400	3100

* Above breakdown of coaxial connectors.

The desirability of some form of antenna protection is quite apparent, for without it the voltage across the load would be in the order of 9000 v./1000 amp. surge current. The star gap gave a reduction in voltage across the load termination in the order of 50 to 1 compared with about 35 to 1 with the stub. The gap is therefore preferable to the stub when it is practical to incorporate such a gap in the antenna design.

Susceptibility to Crushing

Small diameter air dielectric line is particularly susceptible to crushing, so it is desirable to provide a parallel conducting path to divert an appreciable amount of surge current from the outer conductor. When the line is supported on a metal tower, frequent bonding to the structure will provide sufficient parallel conductivity to prevent crushing of the coaxial outer. With lines supported on wooden poles, a conductor should be fastened to the side of the pole opposite the line and bonded to the coaxial outer at both the top and bottom of the pole. Since the division of the current is determined chiefly by the self impedances of the con-

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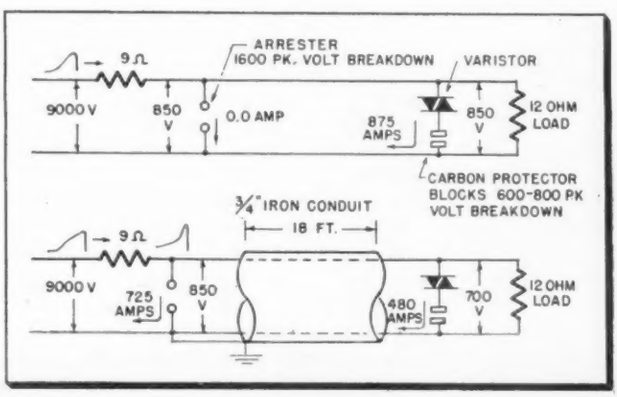
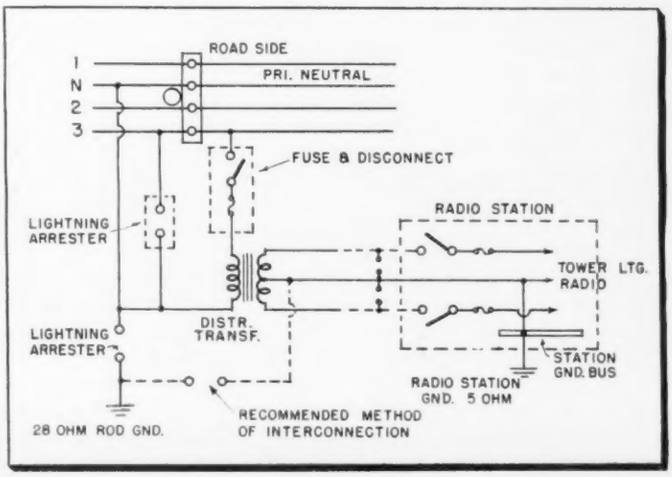
Fig. 4: (L) Impedance of power conduit helps protect equipment

Fig. 5: (R) Power circuit without interconnected neutrals or bridging gap





Power Waveforms in Aircraft

Standard radars found to operate satisfactorily with complex-wave power inputs greatly exceeding existing military specs. Similar tolerance in other designs desirable

A recent study by scientists of the Naval Research Laboratory of the Office of Naval Research has disclosed that currently standard airborne radars can operate satisfactorily on complex wave power inputs which greatly exceed the tolerances presently allowed by existing military specifications. The radar load itself, however, will introduce poor wave forms which may adversely affect other radio or electronic equipment connected in the same overall electrical power system. If all equipments were equally tolerant of complex wave forms, less difficulty would be encountered in aircraft due to disturbance of the power system by the various load components, in the opinion of the NRL scientists.

Since the end of World War II, military aircraft have been getting an increasing number of increasingly complex electronic equipments. This means that the problem of supplying electrical power to these equipments requires constant study.

As one part of continuing investigation of the overall power supply problem, scientists at the Naval Research Laboratory recently concluded a study of the effect of an airborne radar load on the wave form of the ac generator serving as a supply for all the electrical equipment installed in the plane. The primary purpose of this project, which was sponsored by the Navy Bureau of Aeronautics, was to determine an adequate method of specifying generator wave form.

Methods of Measurement

Methods of measurement or specifying wave form were needed which would eliminate or reduce to a minimum difficulties occurring in airborne equipment, principally caused by flashover and hum from rectifiers. Such methods should at the same time lend themselves to production testing of the generators.

An adequate generator wave form specification represents a compromise between the requirements of the supplier and of the consumer of electrical power. The consumer usually prefers a pure sine wave. This cannot be obtained easily and to approach it adds considerable weight and complexity to the generator. On the other hand, if the generator wave form is too complex then the equipment connected thereto may not function properly unless refinements are added which increases its weight.

Many of the generator loads are non-linear and therefore produce harmonics in the load current which, while flowing in the feeders and the generators, produce harmonic voltages which would nullify the refinements of a good sine wave generator.

Loads do not react in the same manner when the wave form deviates from a sine wave. Many loads depend primarily upon the peak value of the wave, while others are dependent upon the average value during a half cycle. Some are influenced by the presence of certain harmonics while still others are dependent upon the point by point deviation from a sine wave. This makes it difficult to find one simple method of measurement which will adequately specify the generator wave form for all loads.

It was recognized that the most difficult part of the research project involved determining the requirements of the more critical consumers of electrical power, principally radio and radar equipment. As a practical first step, it was decided to obtain the opinion of radio-electronic equipment manufacturers on the allowable variation of power source wave form. It was expected that this questionnaire would furnish comments on many of the known methods of specification such as crest factor, form factor, deviation factor, harmonic content, and perhaps would introduce other methods for consideration. The replies, however, did not yield conclusive evidence, in the opinion of the scientists, other than the fact that no one factor would satisfy the requirements of all types of equipment.

The second approach to the wave form specification problem required the determination of the effect of wave form on circuit components of

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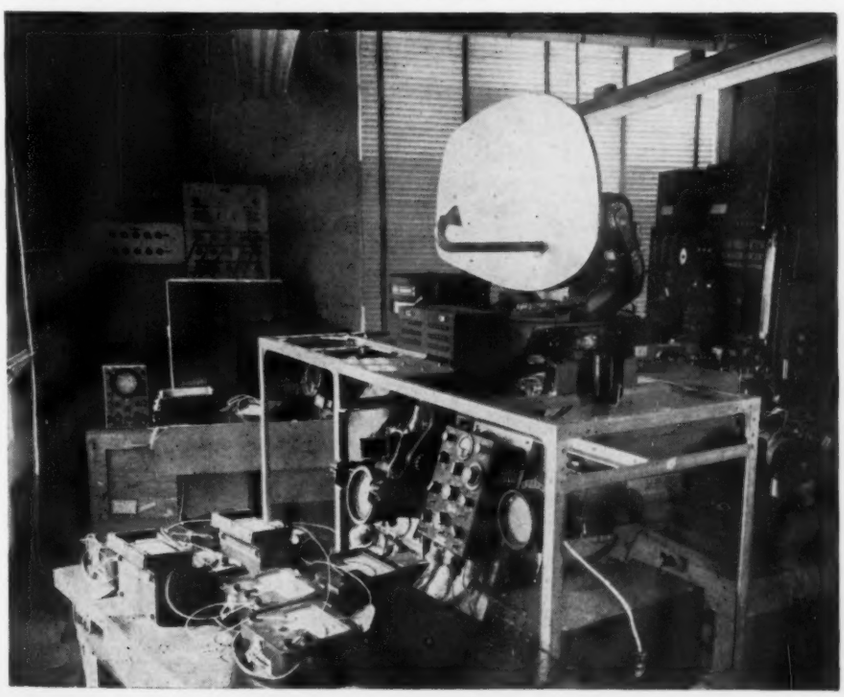
Test set-up used at the Naval Research Laboratory in studying effects of complex-wave form on operation of presently-used airborne radar equipment. Satisfactory operation was obtained even though inputs exceeded crest factors and third harmonic content in current military specifications



Servomechanism Techniques Applied

Test results in physical system show how servo methods more efficient use of process facilities, products having

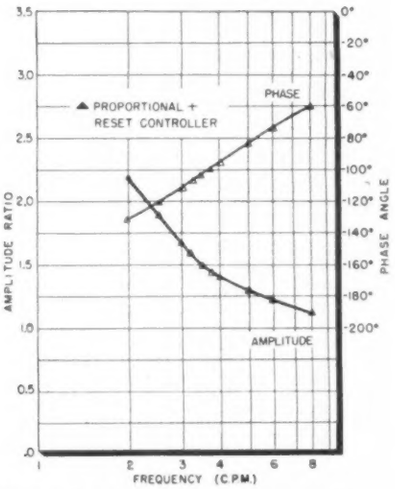


Fig 12: Component frequency response-(B)

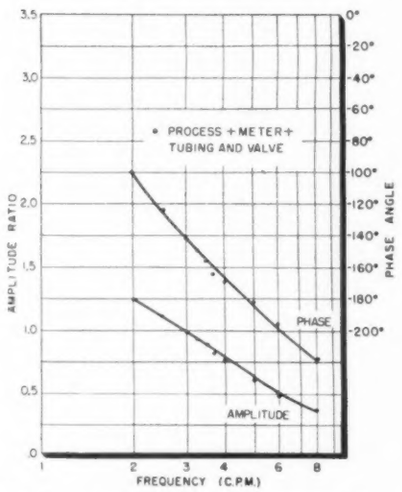


Fig. 13: Component frequency response-(B)

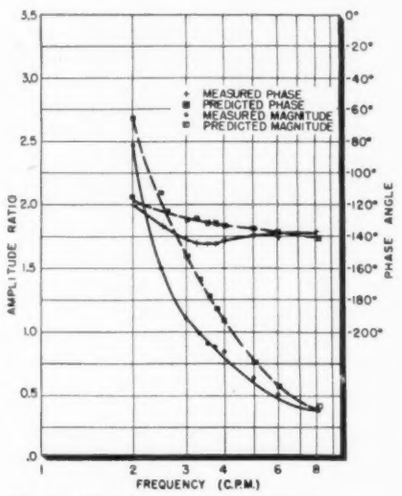


Fig. 14: Open loop response-system B

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TO test the validity of the assumptions, four different flow control systems, as described in Table I were examined using the methods described in Part One.

Thus, the test data will be presented for a typical flow control problem showing the relative effect of controller location as well as a comparison of wet and dry meter operation.

The flow meters were mounted at the orifice using conventional manifolds. The final control element was a standard control valve. No valve positioner was used and the hysteresis curve for the valve is shown in Fig. 7.

Transient plots (response to a sudden step change in set point) were obtained using two conventional two-pen pneumatic receivers with 30-second and 6-minute chart drives.

Controller adjustments were made for each system on the basis of transient response to set point changes for simplicity. No attempt was made to obtain optimum settings for each case so that the systems can not be directly compared from the data. This was done since the purpose of the paper is to show the practical applicability of the approach rather than to provide detailed system information.

Both the set point and the transmitted flow signals were recorded, following a sudden (10% of full scale) change in set point pressure. After these transient tests the controller was subjected to a sinusoidally varying set point pressure covering approximately 20% double amplitude. The flow signal at the controller was then recorded and plots made to show the amplitude and phase of this signal referred to the set point signal.

Transient Response

This plot established the closed loop frequency response for the system under test. The correlation of transient response by the graphical methods previously described and the closed loop frequency response were checked at this point.

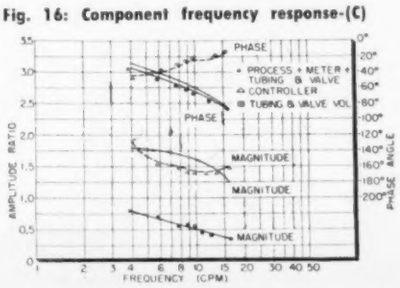
Having established the correlation between the over-all system frequency and transient response, the components contained in the closed loop were individually tested for their response to sinusoidal forcing signals of small amplitude and at the level at which they operated for the closed-loop frequency response tests. The data thus obtained consisted again of amplitude ratio and phase angle between the component output signal and the sinusoidal input. In this case, all inputs and outputs were in the form of pneumatic pressure signals.

The phase shift and amplitude data on the system component at different frequencies constitute the transfer function of the component. The individual transfer functions were combined using standard vector methods to give the over-all transfer function of the system (response of the system to sinusoidally varying signals of different frequencies). The predicted transfer function was then compared with the measured system transfer function to show the degree to which prediction is possible.

The frequency response results on components of System "A" are shown in Figs. 8 and 9.

The system has been broken into three blocks for analysis. Fig. 8

Fig. 16: Component frequency response-(C)



to Manufacturing Problems

PART TWO
OF TWO PARTS

can be employed for predicting system behavior. Through greater uniformity and higher quality may be obtained

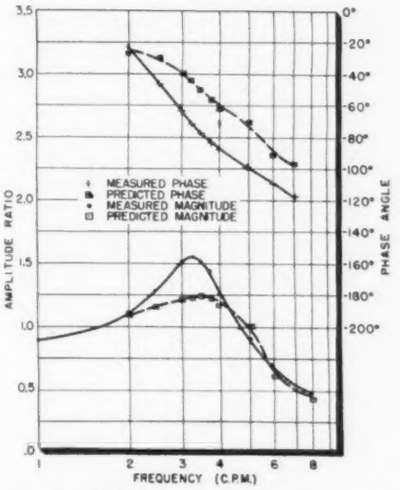


Fig. 15: Closed loop response-system B

shows the diagrams for the controller and for a second block comprised of the mercury meter plus 150 ft of tubing plus the process plus the valve. Fig. 9 shows the transfer function for a third block comprised of 150 ft of tubing and the valve top volume. These individual transfer functions were combined by multiplying amplitude ratios and adding phase angles to derive the predicted open loop transfer function as shown in Fig. 10.

Open-Loop Response

The open-loop response corresponds to the frequency response which would be obtained if the process variable line at the controller were disconnected and its signal recorded when the set point was cycled at various frequencies. The conversion from the open to closed loop frequency response and its inverse is easily accomplished graphically or by charts and will not be discussed here.

Fig. 10 shows the comparison of the actual and predicted open loop frequency response. Note that by using the component curves, the source of undesirable magnitudes and phase shifts can be detected. Any unit which rapidly increases the negative phase angle of the open loop system without a proportional decrease in amplitude ratio will contribute effective dead time to the system and decrease the system stability, thereby making control more difficult.

Closed-Loop Response

The prediction of the closed-loop response derived from component checks and the actual closed-loop response, as measured, are shown in Fig. 11.

Note that the amplitude peak is 1.35 and occurs at a frequency of 2.7 cycles per minute. Thus, from Fig. 5, the damping ratio or ζ is established as 0.4. The dynamic behavior of a second order system having a ζ of 0.4 is shown on Fig. 6. On the basis of this data, the response of system "A," to a set point change was predicted. A comparison of the prediction with the measured response curves is presented in Table II.

The methods used in analyzing the remaining systems are the same as those used for system "A." Consequently, the curves will be presented in the same order and comments will be made on the closed-loop response only.

The effect of changing one component in a system is shown in System "B" (mercury meter with process mounted controller). The component frequency response diagrams are shown in Figs 12 and 13.

The measured and predicted frequency response diagrams for the System "B" closed loop are shown in Fig. 15. Note that by reducing the transmission lag, the negative phase angle (phase lag) was reduced and in fact levels off at approximately $-140°$ above about 3 cycles per minute. Thus the resonant frequency has been increased from 2.7 to 3.3 cycles per minute. It should also be noted that the system stability has been increased. The result of applying the simple approximation for transient response to this system is shown in Table III. The magnification of 1.57 is representative of a ζ of 0.35 and the resonant frequency is 3.3 cycles per minute.

Dry Meter Replacement

In System "C," the mercury meter of System "A" has been replaced with a dry meter. The component frequency response is shown in Fig. 16.

The actual and predicted open-loop responses of the system are shown in Fig. 17.

The measured and predicted closed-loop frequency response diagrams are shown in Fig. 18.

Note that replacing the mercury meter with a dry meter has resulted in a decrease in the phase lag of the measuring system, thus raising the resonant frequency from 2.7 cycles per minute in System "A" to 11 cycles per minute for System "C." This system was intentionally made less stable than the other cases to illustrate the utility of the methods with a minimum amount of system

(*Continued on page* 139)

Fig. 17: Open loop frequency response-(C)

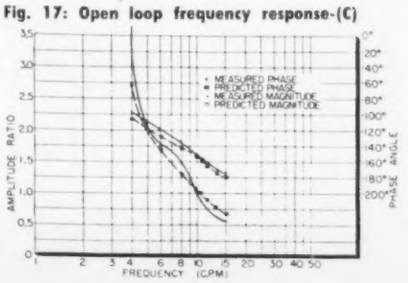


Fig. 18: Closed loop frequency response-(C)

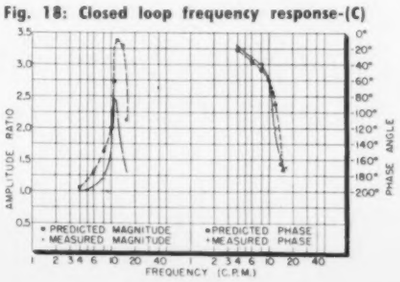
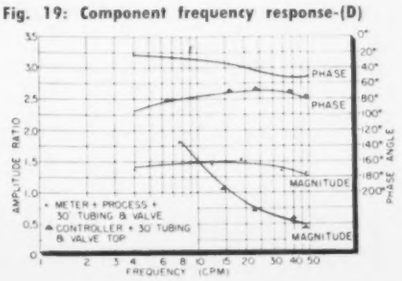


Fig. 19: Component frequency response-(D)



Measuring TV Field Intensities by

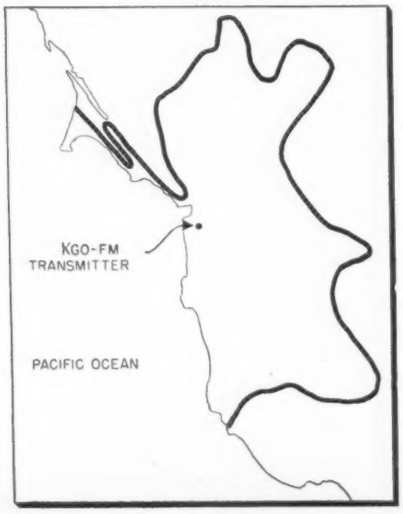
Unusual technique for obtaining radiation patterns eliminates terrain errors found in ground mobile tests. Broadcasting antenna alterations expedited

By JOHN G. PRESTON
Director of Engineering Facilities and General Services,
American Broadcasting Co., 30 Rockefeller Plaza, New York 20, N.Y.

THIS helicopter measuring project stemmed from something approaching desperation after a long search for a fast and accurate method for measuring the radiation pattern performance of installed TV broadcast transmitting antennas. We had long since given up any slight hope that antenna performance could be estimated to even a first approximation by means of either spot or mobile measurements made on the ground.

To illustrate the point, Fig. 1 shows a field intensity contour which was established by ground mobile measurements taken along seven radial routes outward from an FM broadcast station employing a pylon type antenna. This particular antenna is 1200 ft. above average terrain, in a clear, unobstructed location. We are not entirely certain as to the actual horizontal radiation pattern of this pylon antenna but we are quite certain that the pattern shape is reasonably circular and that it surely bears no resemblance to the shape of this contour. Obviously, the true antenna radiation pattern is largely obscured by terrain and other wave propagation effects which influence field intensities near the ground.

Fig. 1: Erratic field intensity contours show shortcomings of ground mobile measurements



In New York City, the transmitter of WJZ-TV, Channel 7, was moved to the Empire State Building in Feb., 1950. For this operation, the antenna was of the simple single section turnstile type and was mounted in an unobstructed location atop a mast on the building. It was considered that the horizontal pattern of this simple turnstile could be assumed to be reasonably circular. During this operation, the customary ground mobile field intensity measurements were made along various radial routes. In 1951, the WJZ-TV operation was transferred to a tower mounted six section antenna of the dipole-screen reflector type and concurrently the effective radiated power was increased by about 7 db over that previously radiated by the single section turnstile. Subsequent ground mobile field intensity measurements were taken over the same routes as the 1950 measurements. The new measurements disclosed that, in comparison with the 1950 data, the new field intensities along certain radials were entirely too low considering the 7 db power increase. A personal interview reception survey which had been made immediately before and after the power increase also disclosed that there had been no consequential field intensity increase in certain directions. Knowing of no way to isolate propagation terrain effects from the ground measurements and thereby deduce antenna radiation performance, we sought a new measurement method which would obviate the propagation intangibles. Decision was made to try measurement by helicopter.

Planning the Project

In planning the helicopter project, it was soon concluded that reliable data could be expected only if the measurements were made at distances at which fields arriving directly from the transmitting antenna would be large relative to any fields arriving after reflection from the ground. Calculation indicated that

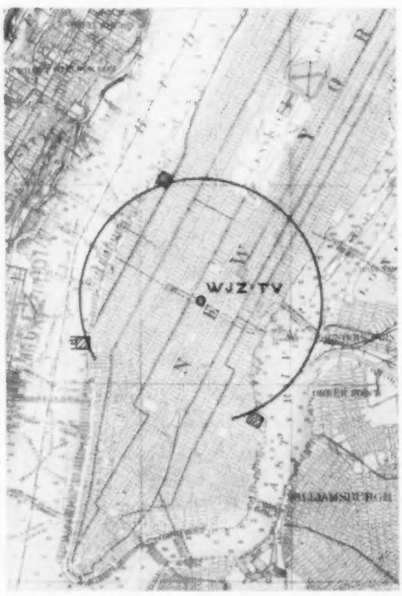


Fig. 2: Flight course of 1.4 mi. radius and 1425 ft. altitude for recording WJZ-TV field

measurements taken within approximately 2 mi. of the antenna would eliminate ground reflected fields of any significant magnitude.

The helicopter measurements were made at an altitude of 1425 ft., the center height of the transmitting antenna, and on a circular course of 1.4 mi. radius around the Empire State Bldg. antenna location.

The circular flight course is shown on Fig. 2, a map of lower Manhattan. This course was chosen to meet the 2 mi. maximum radius limit previously mentioned, to meet flight safety requirements and to provide a course having prominent ground check points for visual navigation. As for safety, the writer found, after committing himself to fly in the helicopter, that this aircraft has gliding characteristics somewhat similar to those of a flat rock. For safe landing in event of engine failure, the ship must go into a 45° glide and must be able to reach a safe landing area within the small radius permitted by this steep glide.

The flight course shown provides safe landing areas in Central Park, and the two rivers—that is, if you consider the river to be a safe place to land on a cold winter morning. It was necessary to avoid flight across

Helicopter

southern Manhattan since there are no emergency landing areas along that portion of the course. The flight course provides good ground features for navigation; for example, a prominent pier structure, a park, Columbus Circle, a small lake, the Third Avenue elevated, the tip of Welfare Island and a Consolidated Edison plant.

Antenna Below Aircraft

A Bell model 47-B helicopter was used for the project. It is pictured in Fig. 3. This is a two place ship rated for a payload of 300 lbs. The doors of the ship were removed to permit maximum visibility of ground check points. This would, no doubt, be delightful in the summertime but it did prove to be somewhat cool on an 8° December morning. The field intensity meter, a Clarke model 106 instrument, was held on the engineer's lap. The receiving antenna, supported on a rod projecting below the aircraft, is a horizontal resonant circular loop of approximately 0.12 wavelength diameter. This loop fed the field intensity meter through a balanced twin coaxial cable. The horizontal radiation pattern of this loop antenna is essentially circular. The support rod was mounted such that it could be easily raised and lowered. The antenna is shown more clearly in Fig. 4.

Fig. 3: Bell helicopter used in flight tests has doors removed to provide maximum ground visibility

A storage battery to power the equipment and a standard 1 ma Esterline-Angus recorder were installed in a baggage hatch, as shown in Fig. 5. Sponge rubber pads were used to shockmount the recorder. In operation, the recorder tape was driven at a speed of 5½ in./min. by the spring motor drive contained in this instrument. A special cable was assembled to provide power, meter and tape marker circuits between the cockpit and the baggage hatch. Installation of measuring equipment in the helicopter required only 15 minutes, once the antenna mount and power cable had been fabricated.

The smooth uniform quality of recordings which resulted from measurements on the circular flight course can best be appreciated by

(*Continued on page* 102)

Fig. 4: Loop antenna in retracted position

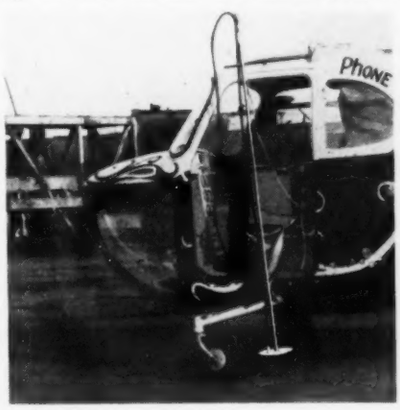


Fig. 5: Recordings made 3.5 mi. (l) and 1.4 mi. (r) from transmitter show ground reflection effect

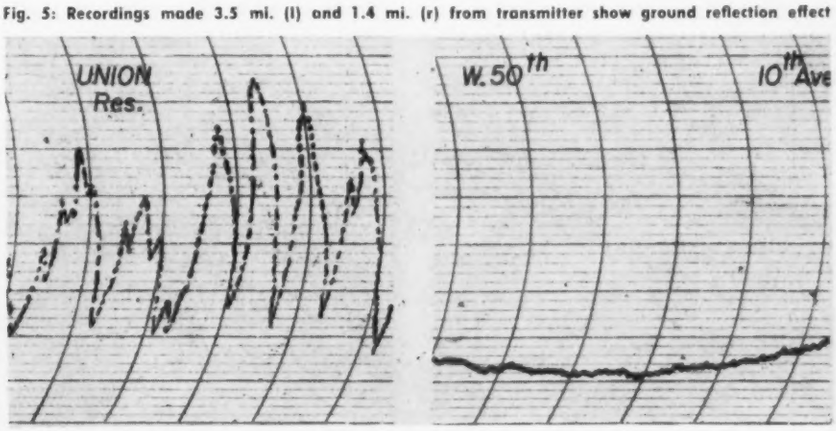
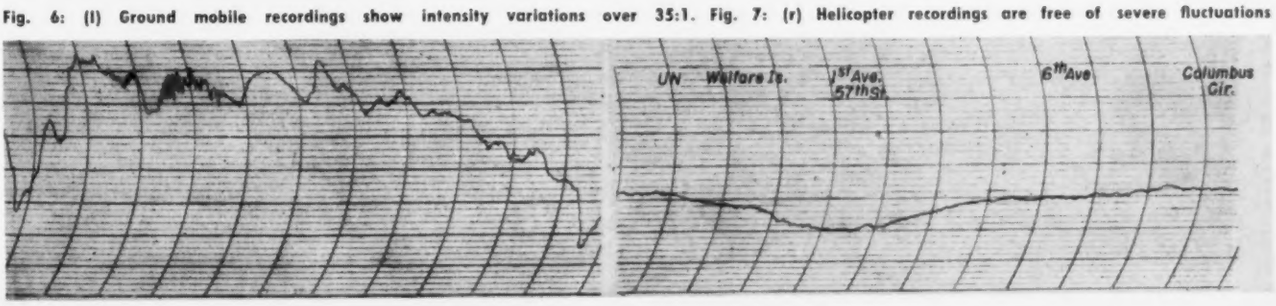


Fig. 6: (l) Ground mobile recordings show intensity variations over 35:1. Fig. 7: (r) Helicopter recordings are free of severe fluctuations



New Aircraft Pictorial Computer

Navigational aid calculates and displays plane's position and bearing in relation to ground radio station. Early commercial certification expected

A valuable aircraft navigational aid has been developed by Arma Corp., Brooklyn, N.Y., which automatically calculates the plane's distance and azimuth in relation to a known OBD (omni-bearing distance) radio station on the ground. The instrument mounts flush on the aircraft panel in front of the pilot and presents a continuous display, showing the plane's orientation on a 10 in. luminous screen. During the next few months, the CAA will evaluate the device and may certify it for commercial use.

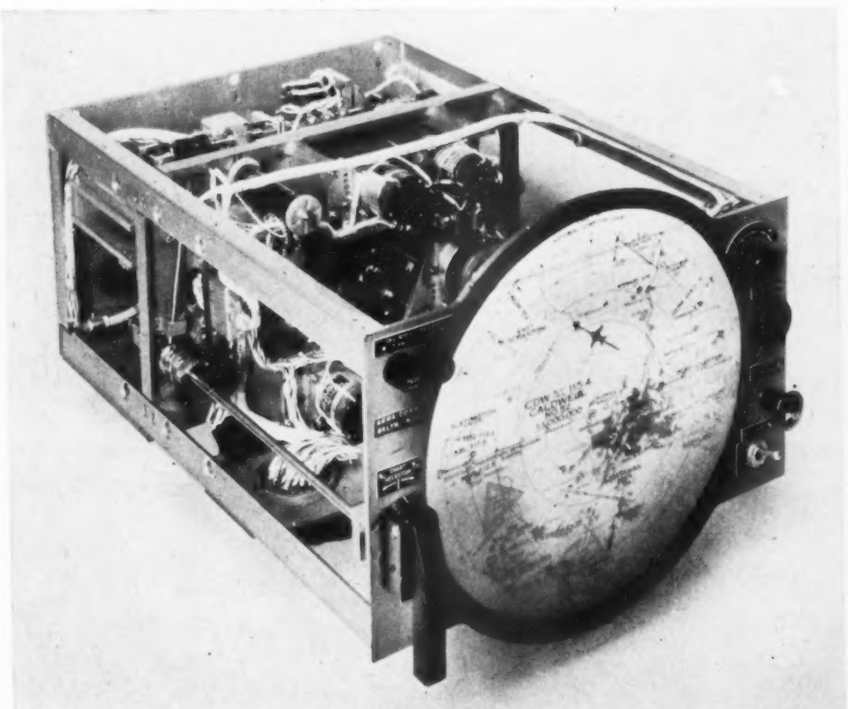
A roll of 35 mm contains a series of charts which cover the OBD stations in operation. As soon as the Coast and Geodetic Survey makes the maps available, some 700 charts will be placed on film. For each ground facility two or three differently scaled maps will be included in one of four scales: Direction Finding (1:2,000,000); Route Chart (1:1,000,000); Sectional Chart (1:500,000); Local Chart (1:250,000). The diameters of these charts cover 274, 137, 64 and 34 miles, respectively. The maps are situated on the films in route sequence order.

Operating Procedure

In operation, the pilot turns the chart selector switch (see Fig. 1), which causes a series of charts to flit across the screen. When the desired chart is observed, the switch is released and the film is locked in place. A 150-watt lamp projects an image on a 10-in. see-through screen at 10X. Concurrently, an arrangement of punched holes in the film operates 11 on-off coded signals to tune the receiver automatically to the OBD station associated with the particular map. Nine fingers interrogate coded locations in the film to actuate a relay network which in turn automatically and remotely controls the autopositioner tuning mechanisms in both the Collins navigational receiver and the distance measuring or range equipment. Two fingers are used to set the scale of the instrument to correspond with the scale of the chart.

The bearing and range information received from one of the OBD stations (291 will eventually be in operation) control three 400-cycle servos which position an airplane outline between the projector and screen. A shadow of the reticle is thereby cast upon the screen showing the exact position and heading of the aircraft in relation to the OBD station in the center of the map. Range is obtained from the shaft orientation of a potentiometer in the distance equipment, which calculates the distance, up to 115 miles, to the station to which it is tuned. Bearing is obtained from the navigational receiver, and magnetic heading is received as a 400 cycle single speed synchro signal from a gyrosyn compass.

Fig. 1: Display unit shows location and direction of aircraft on map covering area surrounding omni-bearing distance radio station. Knobs at left side of panel are spare fuses and chart selector; at right (top to bottom) are brightness control, alarm, spare lamp insertion cable and power switch.



Control Features

Several control features make the pictorial computer a dependable and convenient instrument to operate. Pulling out the slewing handle of the chart selector switch activates the changing mechanism. The handle is then turned to the left or right, depending on whether the desired chart is part of a film strip with a number greater or less than the one being viewed. The greater the amount of turn, the greater is the slewing speed. Release of the handle, regardless of position, deenergizes the selector motor and automatically centers the chart, preventing hunting.

If for any reason the apparatus is not functioning properly, a flag alarm located next to the screen indicates failure. The alarm also operates when the distance to the OBD station is so great that signals received at the aircraft are below the usable threshold strength.

Image brightness may be varied by adjusting a knob on the front panel. Projector lamp minimum life is 100 hours, and average operating life is 150 hours. A spare lamp is provided in the display unit and may

(*Continued on page* 84)

Harry A. Ehle, president Philadelphia Chapter AFCA and vice-president International Resistance Co., (inset) presides at big welcoming luncheon tendered the convention members at the Bellevue-Stratford by Phila. Chapter. Timely speaker introduced by Chairman Ehle was Manly Fleischman, NPA Administrator from Washington

AFCA's Philadelphia Convention

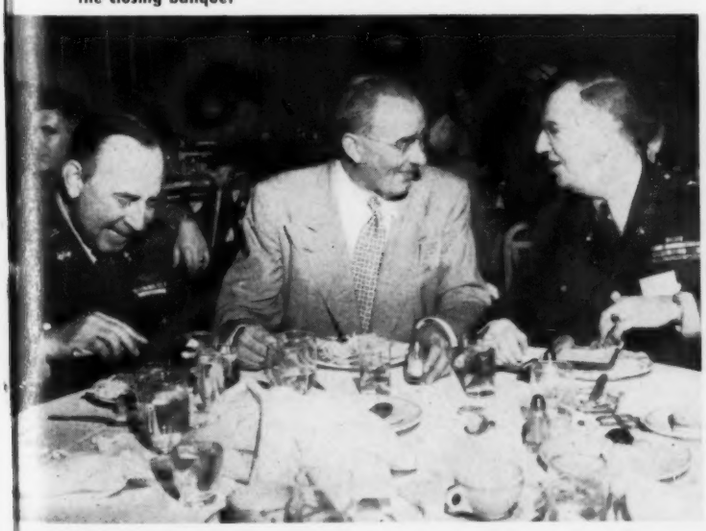
William J. (Bill) Halligan (right), president Hallicrafters, and retiring prexy AFCA, greets NPA Administrator Fleischman

W. Walter Watts, vice-president in charge of RCA Engineering Products, was elected President of the Armed Forces Communications Association at its convention in Philadelphia April 24-25. Mr. Watts, long active in AFCA affairs, succeeds William J. Halligan, president of the Hallicrafters Co.

AFCA vice presidents named for the coming year were: Maj. Gen. George I. Back, Chief Signal Officer of the Army; Rear Adm. William B. Ammon, Director Naval Communications; Maj. Gen. R. C. Maude, Director of Air Force Communications; V. B. Bagnall, general manager AT&T, Long Lines Department Western Area, and Admiral Ellery W. Stone, American Cable & Radio. Col. George P. Dixon was again appointed Executive Secretary. Named to fill the unexpired terms of three Directors who resigned were: Harry Austin, RCA Communications, Harry Ehle, International Resistance Corp.; and Frank Wozencraft.

Exec. Sec. George P. Dixon presents Chapter Award to Col. J. McDavid of Gulf Coast. At head table, Gen. Ingles ex-CSO, and Ted Gary, past-pres. AFCA

Brig. Gen. J. O'Connell, acting CSO, Francis Engle, president Washington chapter AFCA, and Col. Petzing, chief of laboratories at Fort Monmouth, N. J. at the closing banquet



Ted Pope, treas. NY Chapter; "Wally" Watts, new president AFCA; Henry Williams, pres. Baltimore Chapter; Capt. David Hull, Raytheon, Boston; Capt. Furth, USN, and George F. Metcalf, GE, Syracuse, N. Y.

New Developments in

Industry Aids Educational UHF TV

IN an effort to evaluate the effectiveness of TV as a teaching technique, Montclair State Teachers College in New Jersey recently produced ten half-hour programs in cooperation with the DuMont experimental UHF station in New York City. The experiment was financed with funds from a grant to the college by the Allen B. DuMont Foundation. Except for the operation of the transmitter and installation of certain equipment, all sound and camera work, directing and script writing were handled by students.

The programs, originating at the college, were beamed by 6,987.5 MC microwave to the Channel 54 station in New York and broadcast to 400 students in 12 elementary and high schools equipped to receive UHF in their classrooms. Transmissions were made at 709.25 MC visual, and 713.75 MC aural, with 300 and 150 watts, respectively. The video signal derived from a 6-tube 2C39A cavity amplifier was fed to a pair of slotted waveguide antennas mounted back-to-back, and radiated in a fairly omnidirectional pattern with an erp of 5 kw. Reception in the schools some 14 miles distant was reported good.

The student production was satisfactory, but the lack of technical experience made itself evident at several points. However, the important fact is that the experiment provides a basis from which educators may assess various aspects of instructional TV planning, and learn what equipment and know-how would be required to launch educational programs on the UHF channels allocated for this purpose.

Network Pool Covers Political Conventions

PREPARATIONS for radio and TV coverage of the 1952 political conventions in Chicago are rapidly nearing completion. In part, TV considerations influenced the choice of the International Amphitheatre as site for the Republicans' meeting on July 7 and Democratic convention on July 21. The major networks set up a cooperative pool to pick up activities on the arena floor. These proceedings will then be fed to all networks and independents, each of which will have its own commentator describe the sessions.

Supplementary mobile TV and motion picture units as well as pick-ups from party headquarters at the Conrad Hilton Hotel will be used to provide over 60 hours of coverage to 104 TV stations in 62 interconnected cities.

The North wing of the Amphitheatre's second floor will act as operations headquarters. The 305 x 161 ft. area will contain the studios, controls and news rooms, as shown in the diagram of the floor layout. The list below describes the room functions for corresponding numbers on the diagram.

1. Art, secretarial
2. Kitchen
3. Dressing room
4. Mimeograph
5. Air conditioning
6. TV operations
7. TV production
8. Conference
9. Lounge
10. TV studio
11. TV studio
12. TV control
13. News, teletype
14. TV storage
15. Telecine, film edit
16. Radio news
17. Radio storage
18. Tape
19. Radio studio
20. Tape
21. Reception
22. Radio studio
23. Pool office
24. Pool control master
25. Pool TV control

Long Distance VHF Communication Proves Reliable

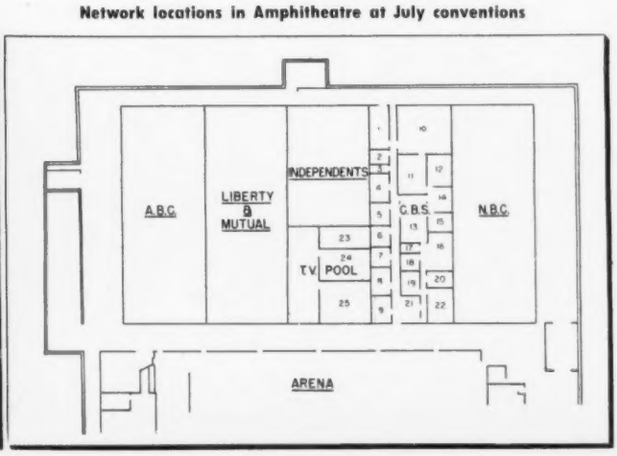
VHF communication, generally considered as limited to line-of-sight transmission, is feasible over distances as great as 1200 miles, according to propagation experiments cooperatively conducted by Collins Radio Co., National Bureau of Standards and Mass. Inst. of Technology, and sponsored by the State Dept. Although received signals were weak, the fact that they were *continuously* observable irrespective of season, time of day or geomagnetic disturbance portends significant possibilities, particularly for point-to-point communication.

On Jan. 23, 1951 experimental transmissions were initiated from the Collins plant at Cedar Rapids, Iowa, to NBS receivers at Sterling, Va. a distance of 774 miles. Operating at 49.8 MC, the CW transmitter fed 23 kw to a horizontal rhombic antenna. Signals were received uninterruptedly on a similar antenna connected to a receiver with 3 db noise figure and 3 KC bandwidth. The antenna arrangement was as follows: height 41.2 ft.; leg length, 500 ft.; tilt angle, 83° (i.e., interior angles of 166° and 14°); gain over dipole, 18 db; main lobe maximum at 7° vertical angle; main lobe half-power widths were 5° vertical, 6° horizontal; effective area, 299 sq. m.

During these transmissions there was no loss of signal reception, except for an occasional equipment failure. In the succeeding months, automatically recorded data exhibited a maximum near midday, a pronounced minimum between 20

Educational UHF TV broadcast originating from Montclair, N. J.

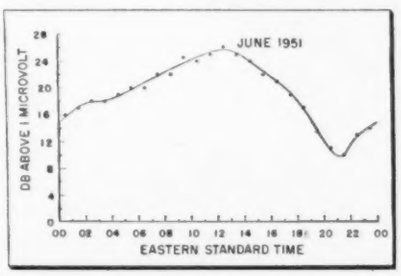
Network locations in Amphitheatre at July conventions



TV and Communications

and 22 hours EST, and a steady increase throughout the night. A plot of the median signal intensities for June 1951, shown in db above 1μv (1μv corresponds to a received available power of 4.2×10^{-16} watt or -154 dbw) indicates this trend. Zero on the db scale represents 1μv open circuit antenna voltage. Initial tests, assuming an ionospheric height of 62 miles, indicated a transmission loss of 72 db.

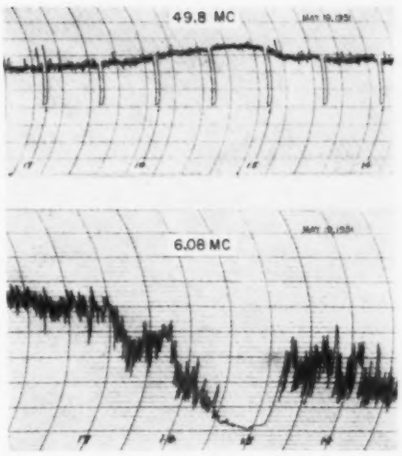
The mechanism of propagation appears to be dependent on ionospheric turbulence reflecting a small part of the incident VHF radiation. It was of the type which might be expected from weak sporadic E-layer reflection, except that this propagation was present at all times. The belief that irregularities in the ionized layers



VHF hourly median signal intensities during June 1951 for 49.8 MC transmission over a distance of 774 miles show pronounced minimum between 20 and 22 hours. No loss of signal was observed due to seasons or disturbances

aid VHF communication is substantiated by close scrutiny of the effects of magnetic disturbances and meteors. During SID's (sudden atmospheric disturbances) which caused the fadeout of 6.08 MC transmissions, the 49.8 MC signal intensity was actually enhanced, as illustrated by the accompanying charts. It is probable that signals were returned from a part of the E-region below the level of maximum ionization, and perhaps even from below the absorbing or D-region.

Meteors were the cause of whistles and abrupt signal level increases. The whistles of descending pitch resulted from reflections from the moving head of ionization accompanying meteors in their passage through the E-region. The concurrent signal rise endured until long after the whistle had ceased, remaining extremely high at times for over a minute.



Sudden ionospheric disturbances on May 19, 1951 caused an enhancement of 49.8 MC intensity over a distance of 774 miles while 6.08 MC transmission showed fadeout over 326 miles

A considerable amount of work is planned to determine the exact mechanism and potential of long distance VHF communication. For example, sporadic signals were received in Bermuda, 1618 miles removed from Cedar Rapids. Usable frequencies may range as high as 100 MC. For the present, any favorable speculation regarding direct cross-country transmission of commercial TV would be overly optimistic, but it appears probable that this important VHF discovery will have significant ramifications in our concept of long distance point-to-point communication.

This information has been made available through the kind cooperation of **The Physical Review**.

Availability of Transistors

AN address by Lt. Col. William R. Starr, GS, of the Electronics Production Resources Agency (EPRA), given at the Symposium on Progress in Quality Electronic Components held in Washington, D. C. on May 6, 1952, outlined the availability of transistors today. These semi-conductor units are presently available in small quantities and a limited number of types.

The military, through the EPRA, is allocating the transistor production of only one company, Western Electric. The purpose of the allocation is to permit distribution to the most urgent government projects. The allocation plan consists of W.E. advising EPRA of the quantity and types available, EPRA calling a conference of the three military departments and the AEC, deciding on the best governmental distribution, and obtaining directive from the NPA.

Col. Starr further pointed out that the government is making every effort to permit the distribution of transistors to as many recipients as possible. NPA amended Regulation 2, Direction 4, April 30, 1952, permits manufacturers to deliver up to 10% of each type's monthly production to any *rated* order, provided no one customer receives more than 50 of each type. NPA Order M-71 permits the assignment of a rating for one in research and development.

To the best of the colonel's knowledge, the accompanying chart summarizes the approximate production and delivery of current sources.

AVAILABILITY OF TRANSISTORS

Company	Current Monthly Production Contact	Current Monthly Production Junction	Delivery Time Contact	Delivery Time Junction	Order Information	Remarks
Federated Semi-Conductor Co.	...	...	...	...	W. N. Kornhauser, Federated Semi-conductor Co., 66 Dey St., New York 7, N.Y.	Sample lots available in May, '52
General Electric	800	...	6-8 wks.	Not quoting	J. H. Sweeney, Electronics Park, Syracuse, N.Y.	Sample lots Junction type Oct.-Nov. '52
Kemtron	...	...	...	...	T. Cassilini, 23 Brown St., Salem, Mass.	Sample lots Point Contact in Sept. '52
Radio Corp. of America	400	...	4-6 wks.	...	Equipment Sales Field Eng. Sect. RCA-Victor Div., 415 S. Fifth St., Harrison, N.J.	Sample lots Junction type Oct.-Dec. '52
Radio Receptor	200	...	4-8 wks.	...	Sales Officer Radio Receptor Co., 251 W. 19th St., New York 11, N.Y.	...
Raytheon	1000	...	4 wks.	Not quoting	C. W. Martel, Special Tube Sect., Newton, Mass.	Sample lots Junction type Nov.-Dec. '52
Sylvania	...	...	...	...	A. Viebranz, Electronics Div., 70 Forsythe St., Boston, Mass.	Sample lots Point contact Aug. '52
Western Electric	6,000	Less than 100	4-wks.	Not quoting	J. E. Tweeddale, 120 Broadway, New York, N.Y.	...

WASHINGTON
News Letter

Latest Radio and Communications News Developments Summarized by TELE-TECH's Washington Bureau

FLOW OF TV APPLICATIONS LATER—The flow of television station applications in any heavy volume to the FCC after the Commission had lifted the 3½-year-old "freeze" in mid-April was not anticipated to come until the latter part of May and during June, since the FCC does not start processing of the projected new video stations' applications until after July 1. The new TV allocations rules became effective 30 days after their official publication in the Federal Register in early May. Of course, the FCC, as it specified in the freeze "thaw" order, is giving priority of attention to the applications from areas without any television service, the ultra-high-frequency station proposals, and to educational television stations.

MANUFACTURERS WELL PREPARED—The radio-television manufacturing industry has assumed an attitude of cautious optimism about the favorable effect of the lifting of the TV freeze, because the industry's leadership realizes the expansion of television under the new allocations plan of the FCC will be necessarily gradual for the first year. In fact, the FCC thaw of the TV freeze has had more of a psychological "lift" for the industry than anything more tangible. The manufacturers have competently planned the filling of the orders for the transmitters and associated equipment for the new TV stations, and the market for new receivers will be slow in building up. A real pickup is not anticipated before the middle of 1953. Because of the improved critical materials situation, the industry is well prepared to move ahead into this new television field.

DEFENSE PROCUREMENT FILLS UP GAP—The procurement contracts of the armed services during this year have been filling up the gap of production of the radio-electronics manufacturing companies considerably more than during 1951. But the threatened deep slash of funds for the Department of Defense by Congress for the 1953 fiscal year, which begins July 1, could well have an injurious impact upon the industry during the latter part of 1953 and in 1954, according to authoritative observers in Washington.

$2 BILLIONS UNDELIVERED—To illustrate the improved situation for the industry during the present year from military equipment contracts, The Army Signal Corps released statistics to TELE-TECH'S Washington Bureau which show that the value of total deliveries during the 1952 fiscal year, ending June 30, is estimated at $613 million, compared to $145,118,000 in the 1951 fiscal period, and the value of undelivered contracts as of next June 30 is estimated at $2,051,000,000, over a half billion dollars more than on June 30, 1951.

TV EDUCATORS WARNED—Educational institutions which are planning to embark into television have been warned by FCC Chairman Paul A. Walker that the "precious" 242 non-commercial, educational TV channels allocated in that field cannot be "reserved indefinitely." The FCC chieftain advised the educators that the assignments might not even be reserved for educational uses beyond one year without "concrete, convincing evidence of the validity of your intent." On the other hand, the FCC's feminine member, Commissioner Frieda Hennock, who is that agency's principal proponent of educational TV, has told educators to apply for their assignments even though their financial resources might be limited. Consensus is the FCC majority will apply standards of financial qualifications to educational TV applicants just as prevails in commercial telecasting.

MOBILE RADIO TRENDS—That mobile radio services must engineer and plan their systems to occupy a minimum of space in the frequency spectrum through reduced channel separation and operation on adjacent channels, is being urged by leading FCC engineers and officials and the top technical executives of the radio-electronic manufacturing companies and of the major mobile radio services. This approach to the problems in the microwave and mobile radio fields has been the most important theme in recent national meetings in the petroleum, public utility, land transportation and police-fire services. Both the FCC top officials and the leading radio engineers in the mobile radio field expect the increased operations to test the use of the 450 megacycle frequencies, and because they have been "very promising," will mean this portion of the spectrum should be important in alleviating future frequency congestion.

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Editor

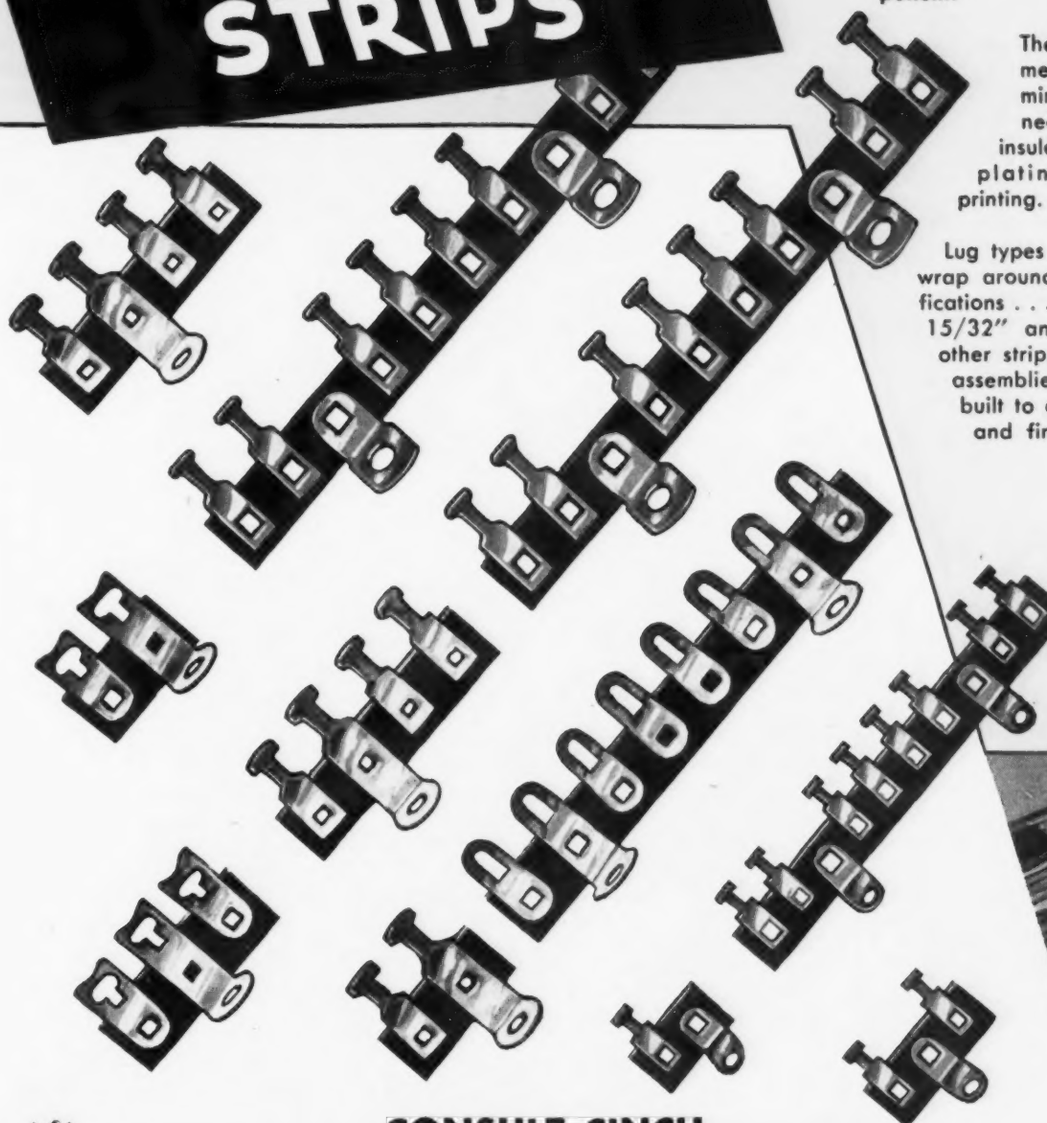
Cinch TERMINAL STRIPS

. . . . . STANDARD FOR COMMERCIAL AND GOVERMENT SPECIFICATIONS

The terminal strip designed by Cinch in the early days of sound transmission, then a "first" is today a standard electronic component.

The exacting quality requirements demand the Cinch terminal strip assembly, insuring necessary higher quality in insulation, tooling, fabrication, plating vacuum waxing and printing.

Lug types include tear drop, T-slot, wrap around, and many other modifications . . . in standard spaced ⅜", 15/32" and ½" strips ⅜" wide; other strip, panel, board and block assemblies available. And custom-built to any specification, material and finish.



Special "miniaturized" strips—actual size shown.

Cinch ELECTRONIC COMPONENTS

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CINCH MANUFACTURING CORPORATION
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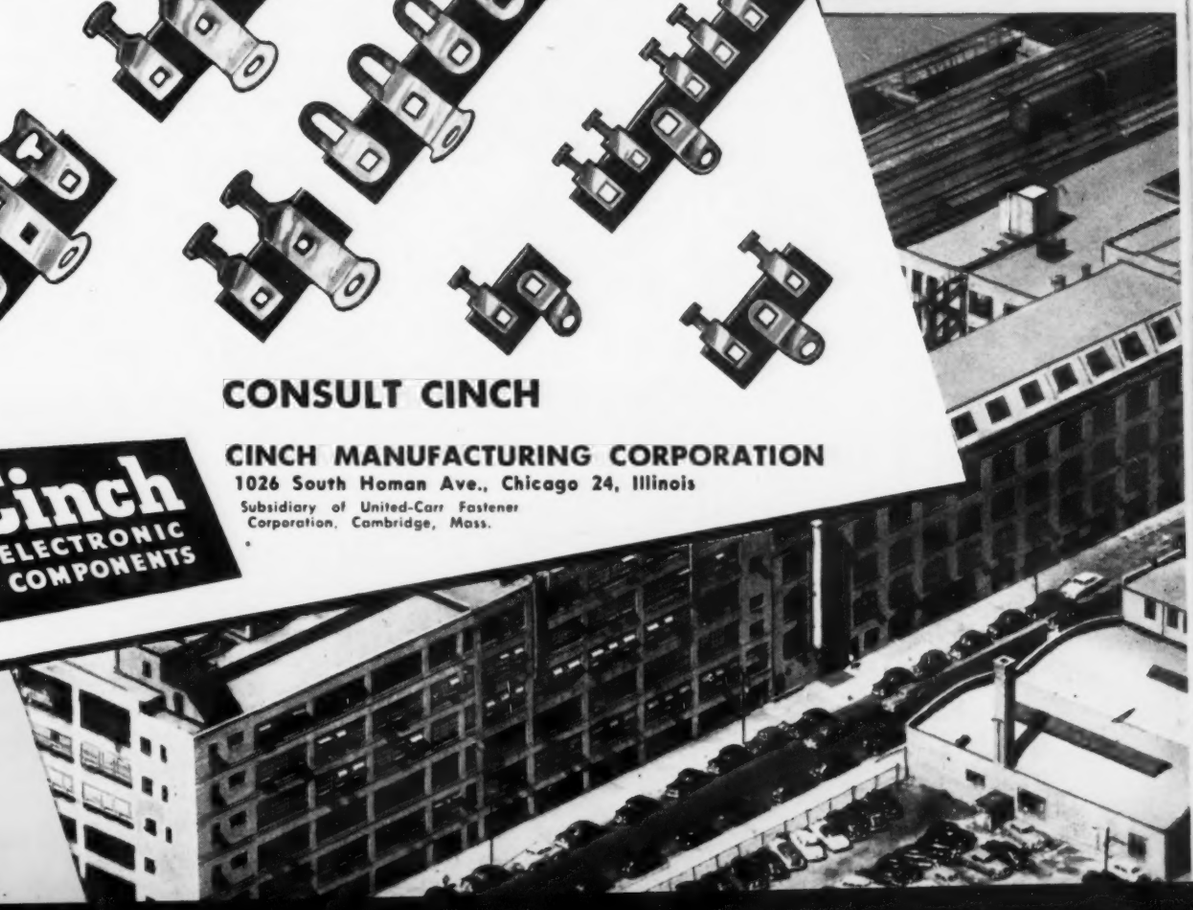

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CUES for BROADCASTERS

(*Continued from page 55*)

visory console" at the transmitter made from a RCA OP-6 remote amplifier and OP-7 portable mixer. This provides any combination of four inputs—studio line, transmitter mike, and two turntables.

Two Rek-O-Kut turntables are incorporated with Western Electric arms and equalizers adaptable for either WE 9-A, or GE variable reluctance heads. The transmitter microphone is suitable for emergency announcements although the acoustics of the transmitter building are not as good as the studio. Generally, only transcriptions and uninterrupted music are fed from the transmitter. The microphone is used in conjunction with a key switch which mutes the monitor amplifier.

Modification was necessary to feed the studio line to the transmitter console because of its relatively high level. By-passing the pre-amp of its mixer channel and feeding it through a 5 db pad and 500 Hi Z matching transformer to the high impedance fader of the OP-7 was the answer. It was found that a 5 db pad was sufficient to equalize the level from the studio with that of the mike and turntables at the transmitter.

Since there is only one line from the studio to the transmitter, a DPDT relay is incorporated to feed the program back to the studio where the studio console monitoring amplifier provides the program. At the transmitter, the output of the supervisory console is bridged by a GE BA-2 program amplifier whose 500-ohm output terminates on one side of the DPDT relay, the other side being the input to the transmitter console. The studio-transmitter line then can be switched between either the input to the console, when the program comes from the studio, or to the output of the BA-2 amplifier back to the studio console where it is monitored. The level sent back is approximately 80% of the normal output of the studio console's output. It will be seen from this operation that it is impossible to have the studio line terminate at the supervisory console and output of the BA-2 simultaneously which, of course, guards against feedback. The conventional simplex method was not incorporated because of the danger of cross-talk.

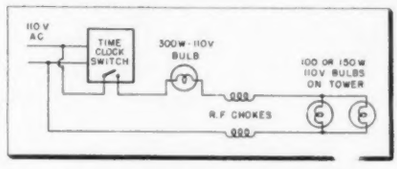
The OP-6 and OP-7 are, for sake of appearance, recessed at an angle in the transmitter control table where all faders are easily accessible to the operator. They can be removed for servicing or use elsewhere as the patch panel can quickly feed the studio line directly to the limiter.

The switches in addition to the four faders are two mercury switches for the turntables, and a switch which activates the relay for feeding cue back to the studio. A 10 db pad is inserted at the input to the limiter to provide the proper level from its supervisory console.

Tower Light Time-Clock Switch

BILL GORDON, Chief Engineer
CJDC, Dawson Creek, B.C., Canada

OUR antenna is a single mast vertical, and the lights are 2-100 watt bulbs. These are fed as shown in the diagrams. With this setup, lights can be seen for a good many miles. The time-clock switch



Life of tower warning lamps extended by inserting 300 watt lamp in series. This also provides indication of proper operation

operates the lights without any attention whatsoever. The only adjustment necessary is changing the time on, time off, cycle of the clock about 4 times a year to compensate for the season. The 300-watt bulb in series with the tower lights not only serves as an indication that the lights are on, but also conserves the life of the bulbs on the tower. Ours have not been replaced since 1947!

Synchronized Recording With Any Tape Recorder

RANGERTONE, 73 Winthrop St., Newark 4, N.J. will now modify any professional or semi-professional magnetic tape recorder to render it suitable for producing lip sync recordings. This means that almost any type of tape recorder can now be used in conjunction with motion picture cameras to provide synchronized sound tracks.

The system uses a special 60-cycle signal which is recorded in such a manner that it is inaudible when picked up by the normal reproducing head. On playback this 60-cycle signal is used to compensate for speed errors due to tape stretch and slipping.

They bring true listening enjoyment to millions—through the finest in modern sound recording methods and equipment

RCA Victor's modern Vinylite phonograph records are infinitely superior to the old shellac pressings of a few years ago. Better in tone quality, distortion, surface noise and frequency range. This improvement in quality requires more precision than ever before in every step of record manufacture and processing. That's particularly true of the original sound recording and the master discs from which the stampers are made. And RCA Victor has found that Audiotape and Audiodiscs are an ideal combination to meet the exacting demands for today's high fidelity phonograph records — Audiotape for clearest recording of the original sound and Audiodiscs for fast, easy processing without loss of sound quality. In fact this record-making combination is now being used with outstanding success by America's *leading producers* of fine phonograph records and broadcast transcriptions.

Whatever *your* recording work may be, Audiotape and Audiodiscs offer you this same sound perfection — the result of more than 12 years of specialized experience by the only company in America devoted solely to the manufacture of fine sound recording media, both discs and tape.

AUDIO DEVICES, Inc.

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...including

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for the original sound

...and **audiodiscs***

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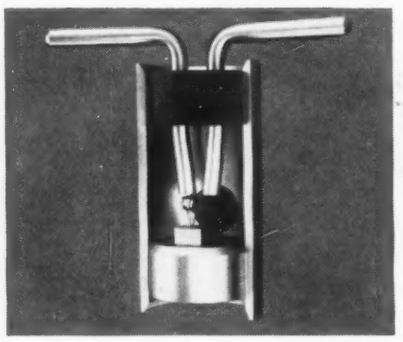
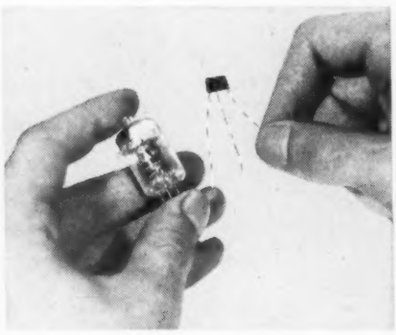
**Trade Mark*

THE TRANSISTOR

A picture report of progress



FIRST TRANSISTORS were of this point contact type (picture three times life size). Current is amplified as it flows between wires through a wafer of germanium metal. These transistors are now being made at the Allentown plant of Western Electric, manufacturing unit of the Bell System. They will be used in a new selector which finds the best routes for calls in Long Distance dialing.



NEW JUNCTION TRANSISTORS, still experimental, also use germanium but have no point contacts. Current is amplified as it flows through germanium "sandwich" —an electron-poor layer of the metal between two electron-rich ends. This new transistor runs on as little as *one-millionth* of the power of small vacuum tubes.

MUCH HAD TO BE LEARNED, especially about the surface of germanium and the effect of one part in a million of alloying materials. Transistors promise many uses—as amplifiers, oscillators, modulators . . . for Local and Long Distance switching . . . to count electrical pulses.

ASSEMBLY PROBLEMS, such as fixing hair-thin wires to barely visible germanium wafers, have been solved through new tools and mechanized techniques. Finished transistors withstand great vibration and shock. Engineers see many opportunities for these rugged devices in national defense.

MOIST PAPER AND COIN generate enough current to drive audio oscillator using junction transistors. Half as big as a penny matchbox, an experimental two-stage transistor amplifier does the work of miniature-tube amplifiers ten times larger.

A tiny amplifying device first announced by Bell Telephone Laboratories in 1948 is about to appear as a versatile element in telephony.

Each step in the work on the transistor . . . from original theory to initial production technique . . . has been carried on within the Laboratories. Thus, Bell scientists demonstrate again how their skills in many fields, from theoretical physics to production engineering, help improve telephone service.

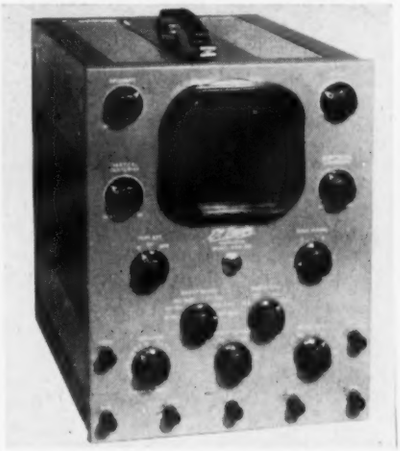
BELL TELEPHONE LABORATORIES

Improving telephone service for America provides careers for creative men in scientific and technical fields.

NEW EQUIPMENT

Oscilloscope

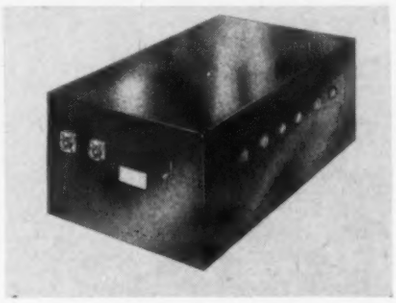
A new laboratory precision oscilloscope incorporates a vertical amplifier of 5 MC bandwidth with 4 in. of vertical deflection without overload and a sweep oscillator



variable from 10 CPS to 150 KC. A special slotted design in the light shield permits easy removal of graduated scale, while a green light filter reduces external light interference. Stability is insured by a Mu-Metal Shield around the cathode ray tube to protect against stray magnetic fields. The vertical amplifier has a sensitivity of 20 mv RMS per in. of deflection; a frequency response (sine wave) of 20 CPS to 5 MC that is down 3 db at 5 MC; a square wave response that is an excellent duplication of all square waves between 50 CPS and 1 MC with a maximum tilt of 5% for 50 cycle square wave; a maximum input potential of 1000 v. peak to peak; and an input attenuator of X1—X10—X100 positions that is frequency compensated. The horizontal amplifier has a sensitivity of 0.3 v. RMS per in. of deflection, and a frequency response (sine wave) that is flat to 300 KC. The recurrent sweep oscillator has a frequency range of 10 CPS to 150 KC in 6 steps, and a linearity that is excellent over an entire range.—**El-Tronics, Inc., 2665 N. Howard St., Philadelphia 33, Pa.**—TELE-TECH.

Magnetic Transient Recorder

A periodic, or "one shot," waveforms can now be permanently recorded and displayed on an oscilloscope, at the leisure of the



researcher, through the use of the 102 magnetic transient recorder. Providing a recording rate of up to 1,000 ppi—or a bandwidth of 1 MC—this low cost, lightweight unit is basically a wideband, analog type, magnetic recorder which can reproduce the recorded waveform at any desired frequency. For example, a periodic output of a Geiger counter can be recorded on the magnetic transient recorder. This waveform can then be reproduced at a desired repetition rate and displayed on any ordinary recurrent, or triggered sweep oscilloscope. Furthermore, adjustment can be made to display any desired portion of the waveform—**Magne-Pulse Corp., 140 Nassau St., New York 38, N. Y.**—TELE-TECH.

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from.....**15 cycles to 6 megacycles**
with accuracy of.....**3% to 3 mc; 5% above**
with input impedance.....**6 mmfds shunted by 11 megs**

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SENSITIVITY • ACCURACY • STABILITY

- Same accuracy at *ALL* points on a logarithmic voltage scale and a uniform DB scale.
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- Provides a 60 DB amplifier flat within 1 DB from 50 cycles to 6 mc.

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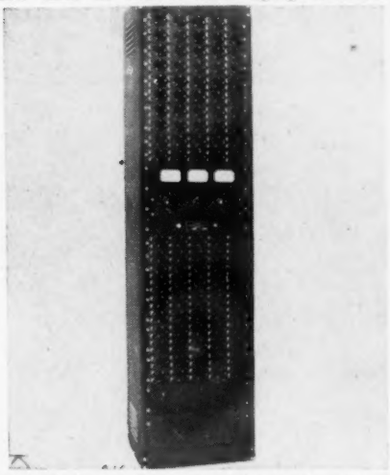
Vacuum Tube Aging Equipment

Type 242 aging unit, designed to age vacuum tubes on a mass production scale, is capable of handling 100 or more tubes at one time in the 50-hour aging tests required by many industrial and military specifications. The equipment can be set up in any number of multiples of 50 or 100 tube units, complete with all associated power and load requirements. Each panel in the rack will accommodate 10 tubes of one tube base type, while the entire rack will handle several types of bases if necessary. Different types of tubes can be accommodated easily by a simple repatching of power connections so that any voltage or load may be connected to any panel. Complete repatching of a panel can be accomplished in less than two minutes. All circuits are fused and metered for continuous heavy duty. Means can be provided for metering each tube element.—**Pennsylvania Testing Laboratory, Doylestown, Pa.**—TELE-TECH.

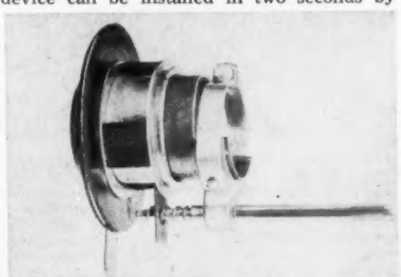


Pressure Transducers

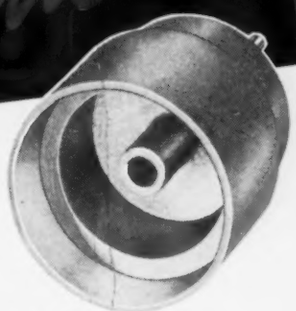
Transducers TR101 and TR102 are precision-built 400-cycle instruments which convert static and differential air pressures, respectively, into electrical signals for use in conjunction with precision instrumentation and analog computers. Design features include: absence of bearing and sliding contacts to eliminate frictional errors which reduce hysteresis and increase repeatability; bourdon tube constructed of zero thermoelastic coefficient material to reduce temperature sensitivity; thermostatically controlled heaters to ensure reliability over wide temperature ranges; and transducer construction which eliminates detrimental effects due to vibration. The transducer is of the electromagnetic type comprising a variable reluctance magnetic pick-off bridge circuit and a cantilever suspended Bourdon tube of unique design. It accepts gas pressure as its input and depends for its operation on a change in the reluctance of the magnetic circuit, thereby eliminating any mechanical friction.—**Servomechanisms, Inc., Post and Stewart Aves., Westbury, N. Y.**—TELE-TECH.

Focusing Device

Designed for use with the new low energy magnetic focus tube, a new TV PM focusing device can be installed in two seconds by simply slipping over the tube's neck and tightening the clamp. Manufacturer states that the price is less than ½ that of previous focusing devices. Other features include a built-in picture positioning device and the fact that there is no interference magnetically or mechanically with other components.—**Heppner Mfg. Co., Round Lake, Ill.**—TELE-TECH.

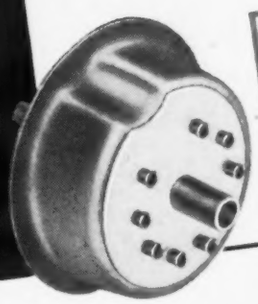


Leadership is a Habit at Hermetic

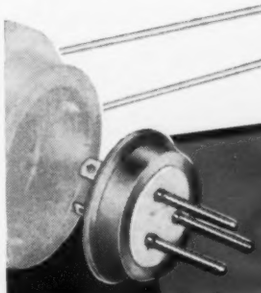


As Shown by These Recent Notable Hermetic Seal Firsts

The design and production of hermetic seals is a job for experts, steeped in this highly specialized activity. Hermetic Seal Products Co. has consistently pioneered and developed the outstanding firsts in ceramic-metal headers. Their experience, know-how and engineering talent are unrivaled in this field. Such specialization assures you of quality hermetic headers in unlimited shapes that will withstand mass spectrometer leak tests, —55°F. conditions, swamp test, temperature cycling, high vacuum, high pressure, salt water immersion and spray, etc. They are the only headers you can hot tin dip at 525°F. for easy assembly soldering for a strain and fissure-free sealed part with resistance of over 10,000 megohms.



Submit your own problems in this highly exacting field to our specialist-engineers. They are eager to be of help. Write for your copy of our new 32-page brochure, the most complete and informative presentation ever made on hermetic seals.



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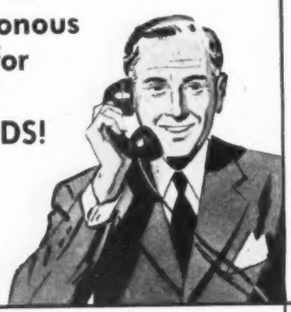
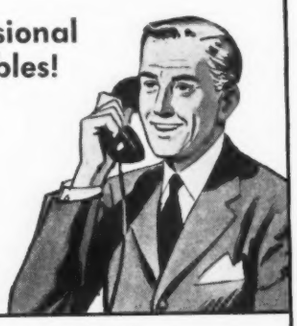
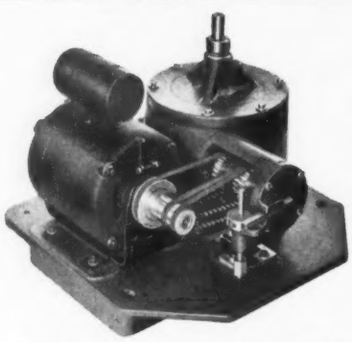
It's the only one with a built-in synchronous drive for ALL 3 SPEEDS!



...and costs less than other professional turntables!



Operates quietly...no turntable vibration or rumble!



Geared belts and geared pulleys insure accurate timing for all 3 speeds.

It's a Fairchild exclusive! The new Model 530 Turntable has the *only* synchronous drive integrally designed and built for three speeds. No attachments, no kits are necessary. It reaches *stable speed*—less than ½ revolution at 33⅓ without overshooting. Offers *guaranteed accurate timing* within limits of AC line frequency. Turntable rumble and vibration are practically non-existent.

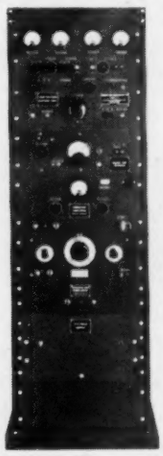
And . . . the new Fairchild Model 530 *costs less* than other quality turntables. Bulletin PB10 contains complete data on Fairchild's new, wide-range line of playback equipment. Write for your copy.

FAIRCHILD RECORDING EQUIPMENT

154TH STREET & SEVENTH AVENUE, WHITESTONE, NEW YORK

Vacuum Tube Vibration Test Set

Receiving tubes, including miniature and subminiature types, can be tested under static voltage conditions by the model TS-1 which also can subject them to vibrations of 10 to



1000 cps. Noise output is measured by a VTVM having a range of 0.001 to 100 v. rms. High-stability oscillator with a frequency range of 10 cps to 20 KC will drive the vibrator or can be used as a separate audio oscillator. Tube socket connections may be varied in accordance with the requirements of any particular type under test.—**General Electrosonics, Inc., 32 W. 22nd St., New York 10, N. Y.**—TELE-TECH.

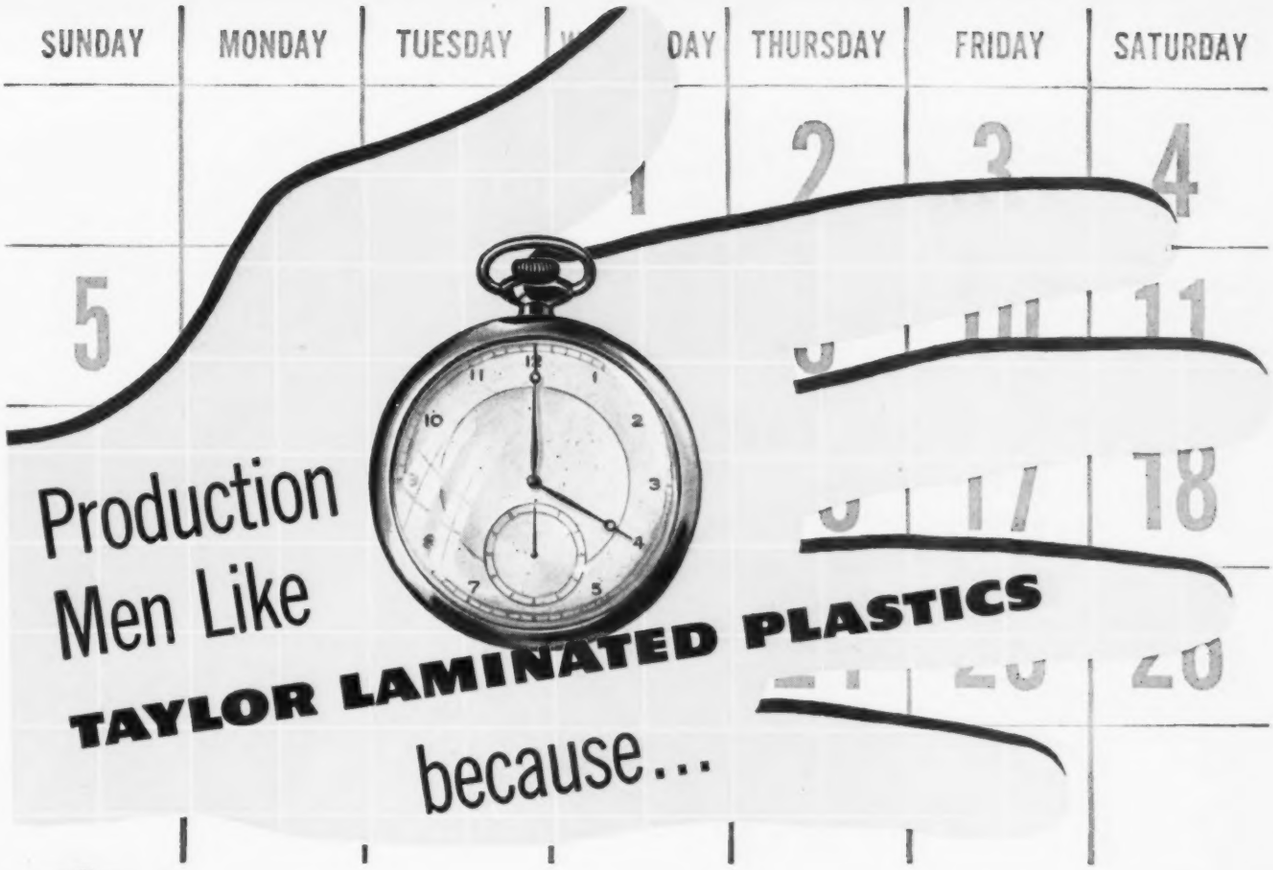
Standing Wave Amplifier

The type 275 amplifier is a high gain linear audio amplifier for indicating voltage standing wave ratios over the following full scale ranges: 1:1.3, 1:3, 3:10, 10:30, and 30:100. A normalizing gain control channel minimizes the effect of power drift on the r-f source. The unit may be operated as either a broadband amplifier over the range of 300 to 3000 CPS or as a narrow band amplifier at 500, 1000, and 1300 CPS with a 25 CPS pass band. Particular attention has been given to providing excellent shielding which is in part responsible for the low noise level of 0.03 μ v. The full scale narrow band sensitivity is 0.1 μ v. The input circuit provides for either crystal or bolometer operation with a variable bolometer bias of 2.5 to 8 ma. The square law meter, calibrated to read directly in db and the high voltage gain of 140 db, makes this unit particularly suitable for microwave attenuation measurements with a bolometer r-f detector.—**Polytechnic Research and Development Co., 55 Johnson St., Brooklyn, N. Y.**—TELE-TECH.

CR Tube

A new CR tube for radar indicator service reduces undesirable screen charging. Known as the 7UP7, the new tube employs magnetic focus and magnetic deflection and

can be used as a replacement for the 7BP7 or the 7BP7-A. A reflective aluminized screen reduces undesirable screen charging, permitting more accurate plotting directly from the face of the tube. The aluminized screen also leads to improved resolution and definition, a reduction in screen burns, and a longer tube life. The new tube also uses an improved anode contact design, aimed at decreasing corona discharge, permitting operation at higher altitudes. A recessed small-cavity cap has been used on the anode contact instead of the conventional recessed small-ball cap.—**General Electric Co., Tube Dept., Schenectady 5, N. Y.**—TELE-TECH.



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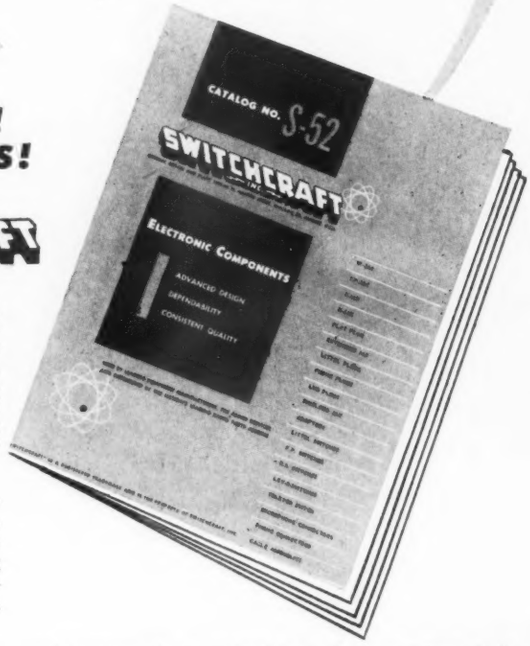

This new Switchcraft catalog is unique in its completeness which enables you to find the component part you need, quickly. The new products broaden the adaptability of the Switchcraft line, to meet the requirements of your equipment.

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NEW "MICROPHONE CONNECTORS"—for use with single conductor microphone cable—ideal for input grid circuits. NEW "PHONO CONNECTORS"—low cost for record players, FM-AM tuners, and sound recording equipment.

NEW "TELEVER" SWITCH—Rugged type lever switch of light but rugged construction, for applications requiring dependable switching.

NEW "CABLE ASSEMBLIES"—Standard 25 ft. lengths of 2 and 3 conductor rubber covered cable, shielded and multi-conductor types—assembled to popular Switchcraft Components.

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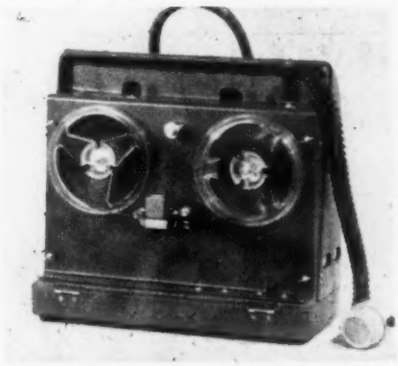
Portable Tape Recorder



The "Parlo-Tape" is a completely portable, two-speed tape recorder operating from self-contained batteries. Recordings can be made anywhere with its own electric power—no need to plug into an electrical outlet—no need to wait for tube warm-up, as this is instantaneous. Recordings can be started instantly by turning the knob to "Record" position, or played back by turning the knob to "Listen" position. Operator can listen to the recording either by holding the microphone to the ear, or by plugging an amplifier into the microphone socket. By using a microphone equipped with push-to-talk switch, recording can be started instantaneously or stopped with the switch on the microphone. Automatic volume control feature provides for a stable recording level at various distances from the microphone. All or part of the tape can be "erased" right on the machine and re-used again and again.—**Made by Ectro, Inc., Delaware, Ohio. Exports through M. Simons & Sons, Inc., 25 Warren St., New York 7, N. Y.**—TELE-TECH.

Wire-Wound Resistors

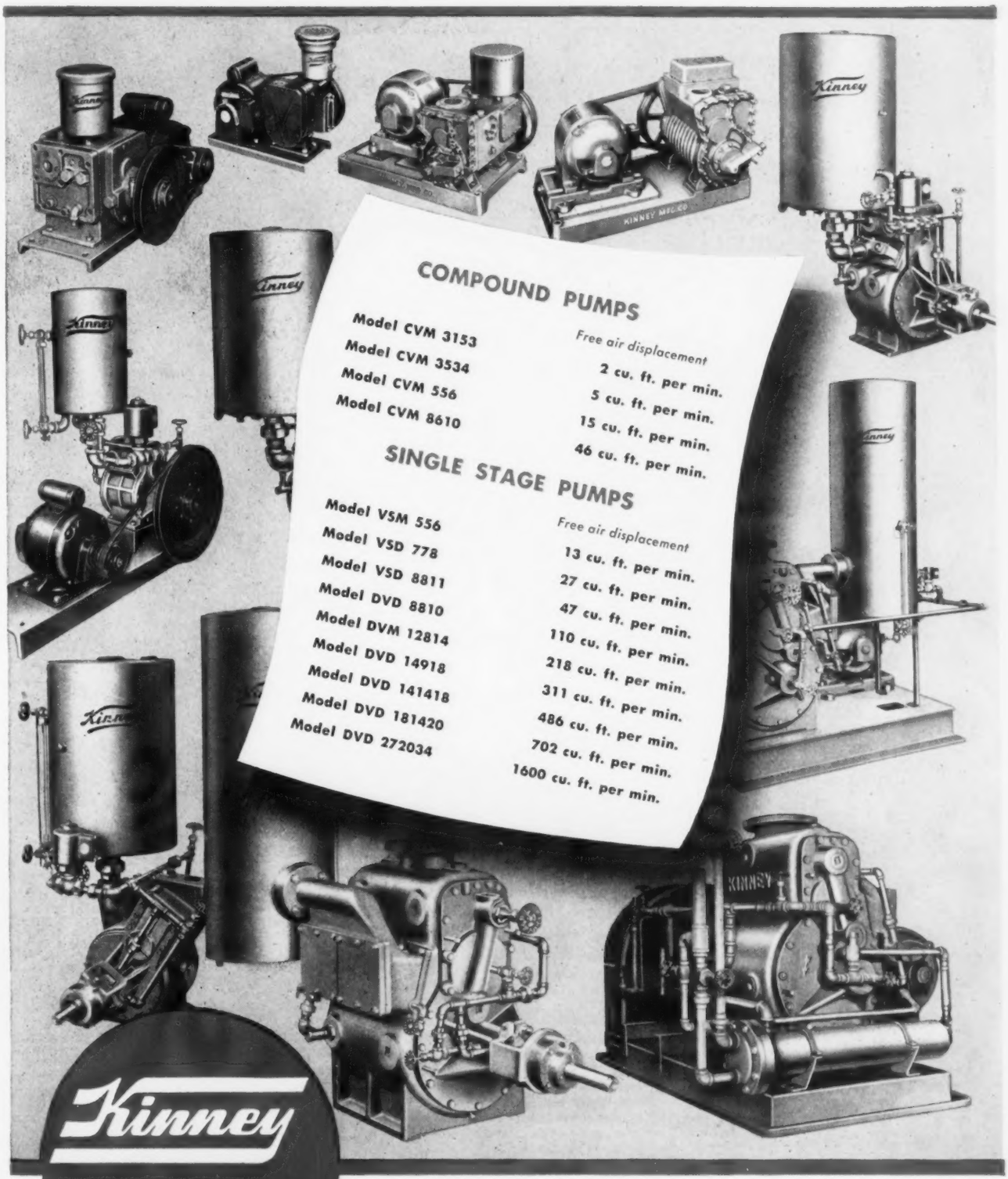
A new humidity-resistant vitreous-enamel wire-wound resistor will withstand the severe performance requirements for characteristic G and J units in Joint Army-Navy specification JAN-R-26A. Initial production is in the complete range of military styles RW39.—**Sprague Electric Co., 233 Marshall St., North Adams, Mass.**—TELE-TECH.

TV Crane

A new television camera crane, known as model TC-1, allows virtually every camera effect known to television; from very high to very low "on the air" fluid-motion shots, vertical and horizontal panning, long and

continuous running dolly shots or any combination of these effects. It operates smoothly, steadily, quietly and with a minimum of effort. A counterbalanced boom is mounted on the mobile chassis by means of a rotating center column. The camera and cameraman are supported on a rotating mount on forward end of the boom, balanced by lead weights in a box on rear of the boom. Accurate balancing makes possible raising and lowering manually with minimum effort. Boom can also be rotated full 360° easily and smoothly. The camera platform, carrying cameraman seated comfortably behind camera, rotates independently of boom for horizontal panning and is propelled by the cameraman through the use of foot pedals.—**Houston-Fearless Corp., 11805 W. Olympic Blvd., Los Angeles 64, Calif.**—TELE-TECH.

THE BIG LINE OF VACUUM PUMPS



COMPOUND PUMPS

	Free air displacement
Model CVM 3153	2 cu. ft. per min.
Model CVM 3534	5 cu. ft. per min.
Model CVM 556	15 cu. ft. per min.
Model CVM 8610	46 cu. ft. per min.

SINGLE STAGE PUMPS

	Free air displacement
Model V5M 556	13 cu. ft. per min.
Model V5D 778	27 cu. ft. per min.
Model V5D 8811	47 cu. ft. per min.
Model DVD 8810	110 cu. ft. per min.
Model DVM 12814	218 cu. ft. per min.
Model DVD 14918	311 cu. ft. per min.
Model DVD 141418	486 cu. ft. per min.
Model DVD 181420	702 cu. ft. per min.
Model DVD 272034	1600 cu. ft. per min.

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VACUUM PUMPS

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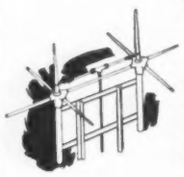

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High gain cavity fed corner antenna for either vertical or horizontal polarization. Rugged, lightweight, completely weatherized. Three types providing ranges from 360-2200 mc.

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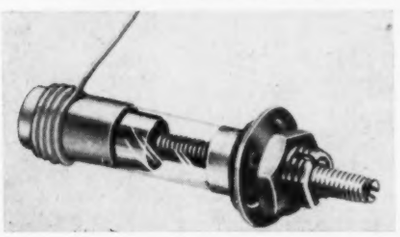
Voltmeter

Model 314 electronic voltmeter measures ac voltages from 100 mv to 1000 v. in the 15 CPS to 6 MC frequency range. Its accuracy of 3% up to 3 MC and 5% above is

the same at all points on the single logarithmic voltage scale. With its probe, the input impedance is 6 $\mu\mu$f shunted by 11 megohms and the voltage range is 1 mv to 1000 v. in 6 decade ranges. Without its probe it may be used to measure down to 100 mv but the input impedance is reduced to 25$\mu\mu$f shunted by 1.1 megohms. Stabilization is accomplished by the generous use of negative feedback. One of its features is the unique probe which has a self-holding connector tip and also a group clamp especially designed to insure a low impedance ground return. It may also be used as a wide band amplifier with maximum gain of 60 db variable in 20 db steps and flat within ½ db from 100 CPS to 3 MC and within 1 db from 50 CPS to 6 MC.—**Ballantine Laboratories, Inc., Boonton, N. J.**—TELE-TECH.

Variable Capacitor

A new series of piston type variable trimmer capacitors are provided with a one-piece spring loaded piston and screw manufactured with a special unvar alloy. This

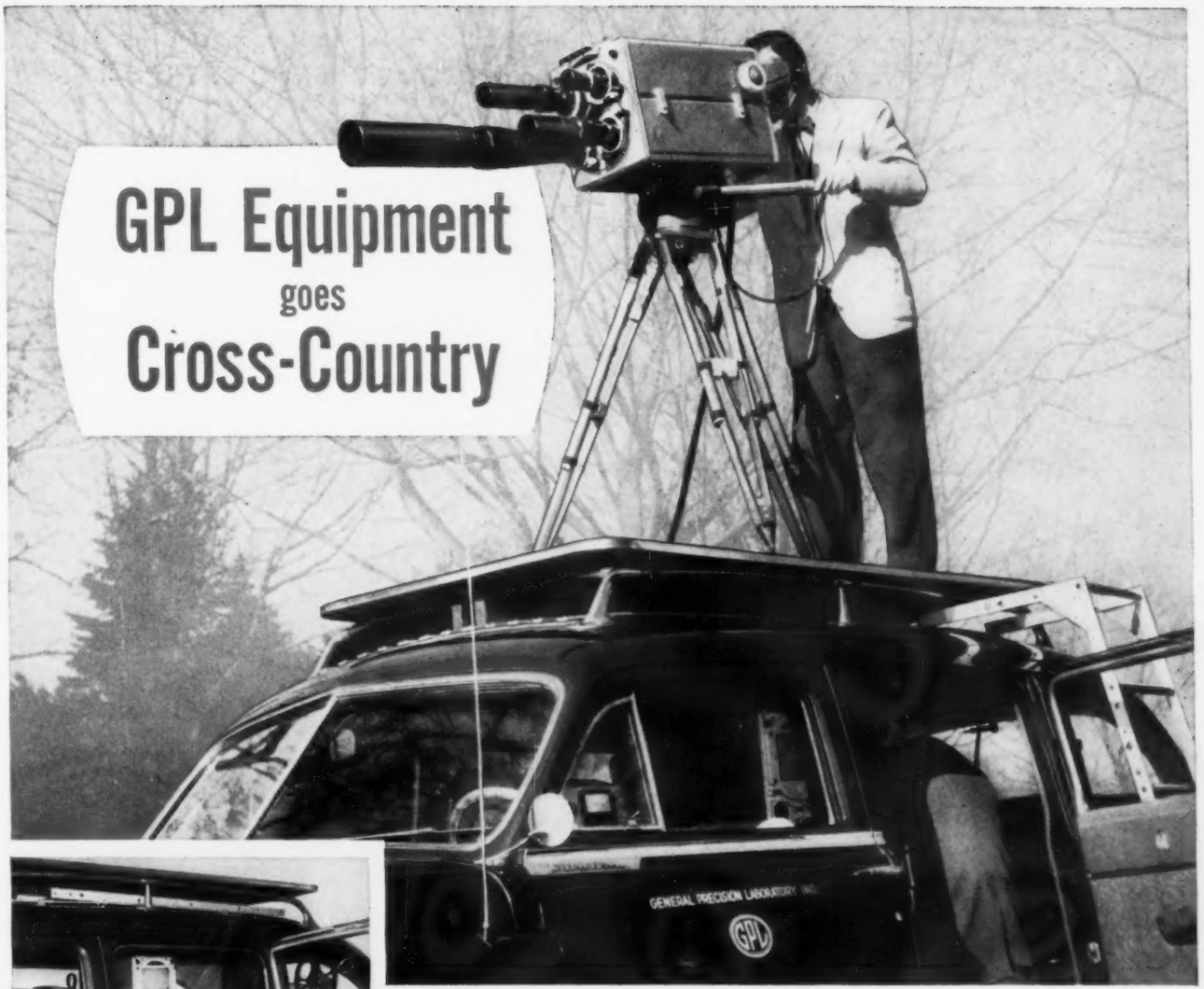


alloy has an extremely low temperature coefficient of expansion. In addition, a silver band is fused in to the surface of precision drawn quartz, or glass where glass is needed. This silver band serves as a stationary electrode. The three piston type capacitors are VC5 (0.5 to 5μ f.) quartz dielectric, the VC11 (1 to 10μ f.) also quartz dielectric and the VC11 (0.5 to 12μ f.) glass dielectric. Tubular in design, these capacitors deliver continuous and uniform changes in capacitance in relation to the rotation of the invar piston. They permit precise adjustments with no mechanical or electric backlash or disturbance.—**JFD Mfg. Co., Inc., 6101 16th Ave., Brooklyn 4, N. Y.**—TELE-TECH.

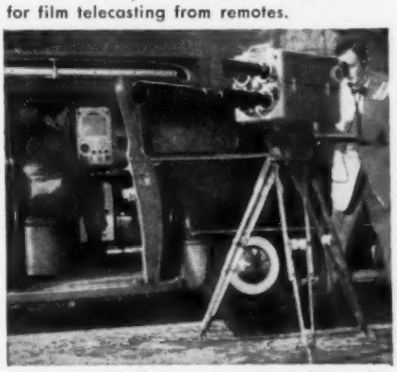
Regulated Power Supply

Model A3 regulated power supply features flexible, continuously-variable dc voltage output from 0 to +400 with 0.5% regulation at loads from 0 to 200 ma. Other outputs are: +v. dc unregulated. 0 to −150 v. dc variable and stabilized and 6.3 v. ac at 5 amp. Output ripple voltage is less than 10 mv. Output impedance is less than 10 ohms dc, and less than 2 ohms from 20 CPS to 50 KC A 40 μf capacity may be switched across the regulated output to accommodate large peak-current loads. Meters are provided to monitor the output voltages and current.—**Oregon Electronic Mfg. Co., 206 S. W. Washington St., Portland 4, Oregon.**—TELE-TECH.

GPL Equipment goes Cross-Country



Included in cross-country demonstration unit is the GPL Utility Projector, with "3-2" intermittent which permits use with I.O. camera for film telecasting from remotes.



Compact GPL studio camera chain fits easily in station wagon, and may be operated from there, drawing power by cable from studio and returning signal to transmitter.

...to Drive its Story Home!

Stations all over the country will soon be able to see GPL TV equipment in operation right in their own studios. They can compare it with their present equipment, try it for compactness, smooth efficiency, flexibility, operational simplicity, and overall performance quality. Maintenance-minded engineers will examine its swing-up, swing-out panels. Camera and camera control men will note its many new operating features – pushbutton turret control, remoting of focus, turret and iris—all engineered for faster, smoother control.

Be sure *your* station is on the schedule of the GPL Mobile Unit Tour. *See* why network users have said: "Best picture on the air today!" Compare "the industry's leading line—in quality, in design."

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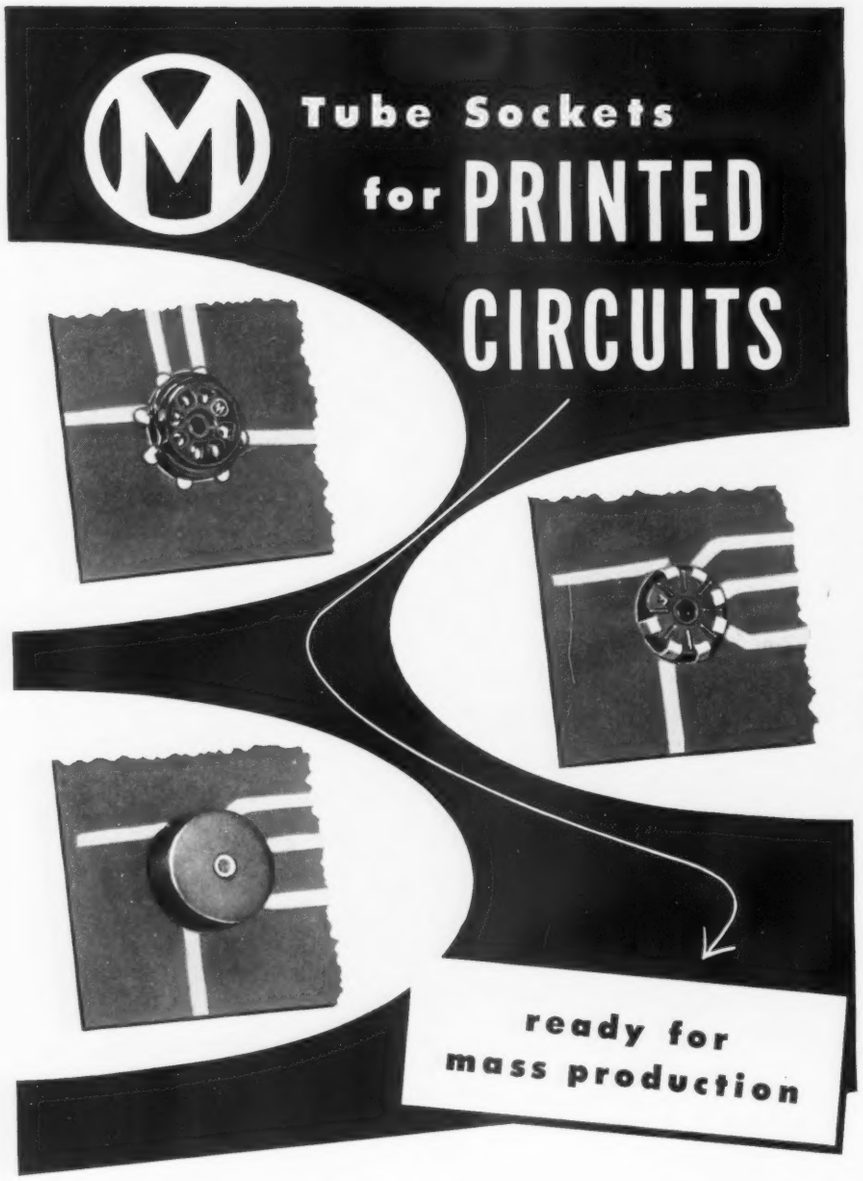

METHODE, now ready with volume production capacity on seven pin miniature tube sockets for printed circuit application . . . offers units with simple, time-proven design features providing reinforced mechanical spring contact with printed conductors, easily supplemented by solder dip operations. Insulators and retainer caps are heat resistant black phenolic and hardware is cadmium plated copper base alloy.

Recommended Usage: 1) sockets are snapped into keyed holes of $^{43}/_{64}$" diameter; 2) insulating panel is solder dipped on under side to fuse socket terminals to printed conductors; 3) supplementary connections for top panel connections, if necessary, are spot soldered; 4) retainer cap is eyeletted or screwed to socket, locking assembly to board and assuring pressure contact.

We invite your inquiries

METHODE Manufacturing Corp.
2021 West Churchill Street
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Geared to produce
Plastic and Metal Electronic Components

Pictorial Computer

(*Continued from page* 66)

be brought into position in the optical system by pulling a flexible cable at the front of the unit. The flexible cable is left out a length of 2 in. as a reminder to replace lamps at the next ground facility.

The overall power consumption is 250 watts. Accuracies claimed are: range ±0.4 miles at all scales; bearing ±0.5° or ±1/32 in.; and heading ±1°. The size of the display unit is about 13 x 7.5 x 17.5 in., exclusive of

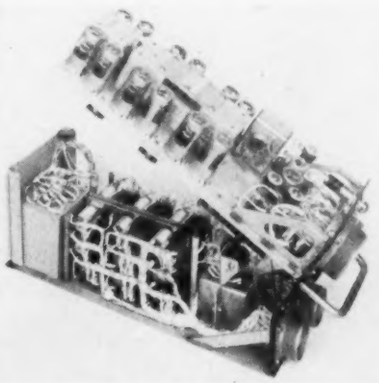

Fig. 2: Amplifier unit with cover removed

blisters at the front to accommodate the screen and at the rear for the lamp house and its blower. Weight of the display unit without shockmounts is 16 lbs. The amplifier unit (Fig. 2) is packaged within the outline of a standard S-2 case and weighs 21 lbs. including shockmounts.

Pilots should find no problem in using the pictorial computer. It is easily viewed at 40 in. and new charts may be selected within 10 seconds. Depending on aircraft speed and chart scale, chart changes should be required at intervals of 15 to 30 minutes.

An interesting feature of the system is its potential use in auxiliary applications. By incorporating a system of reticles in the shape of printed words, the unit can be used to transmit standard communications phrases from tower to pilot. A signal from the ground would cause the desired reticle to project its outline on the screen, thereby supplementing aural landing instructions. Another auxiliary use would be as a remote indicator or alarm for other instruments in the plane.

This indicator should prove a valuable safety aid in air navigation, for it tells the pilot in picture form, a form easily the equivalent of ten kilowords, "This is exactly where you are, and the direction you're heading."

for ALL These Types

for ALL These Sizes

for ALL These Ratings

VOLTAGE REGULATOR AND REFERENCE TUBES

TYPE	MAX. DIMENSIONS INCHES		MIN. STARTING VOLTAGE SUPPLY	OPERATING VOLTAGE (Approx.)	MIN. OPERATING CURRENT MA.	MAX. OPERATING CURRENT MA.	MAX. REGULATION VOLTS
	HEIGHT	DIAM.					
OA2	2.63	.75	185	150	5	30	6
OB2	2.63	.75	133	108	5	30	4
CK1017	2.69	.75	750	700	.005	.055	15
CK1022	2.69	.75	1100	1000	.005	.055	20
CK1037	1.75	.40	720	700	.005	.100	15
CK1038	1.75	.40	925	900	.005	.055	15
CK1039	1.75	.40	1230	1200	.005	.100	25
CK5651*	2.13	.75	115	87	1.5	3.5	3
CK5783*	1.63	.40	115	87	1.5	3.5	3
CK5787	2.06	.40	141	100	5	30	6
CK5962	2.69	.75	730	700	.005	.055	15
CK6213	1.38	.40	200	130	1.0	2.5	2

*Voltage Reference Tube

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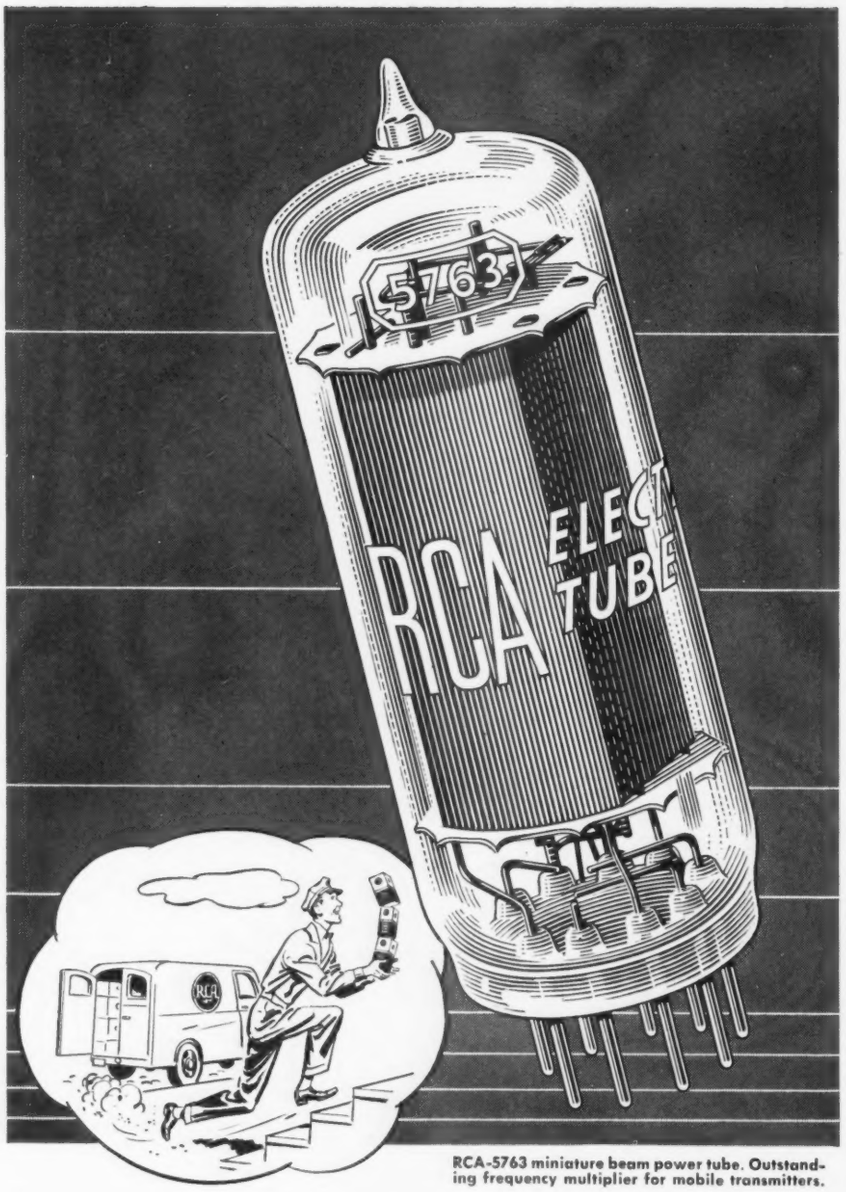

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RADIO CORPORATION of AMERICA
ELECTRON TUBES HARRISON, N.J.

Ionophone

(*Continued from page* 49)

stricted by the associated horn system which couples the Ionophone to the air. Using an exponential horn with a 4 x 5 ft. mouth, satisfactory response is reported to be in the vicinity of 200 cps. Response is substantially flat up to the highest audible frequencies. Although the upper limit has not been investigated completely, useful levels of energy have been generated up to 40 kc.

Distortionless reproduction is an outstanding advantage of the Ionophone. Unhampered by conventional diaphragm limitations such as transient disturbance, natural vibration period and high frequency hangover, this transducer presents potentialities for high fidelity work. Also, the linearity of driving circuits may be enhanced because modulation can be maintained at the low figure of 20-30%.

Efficiency in terms of audio power input to acoustic output has been measured by the inventor at 7%. In one demonstration, the input was 7 watts r-f and 3 watts audio power. These levels produced ample volume in a 20,000 cu. ft. absorbent room. However, under different testing circumstances there are indications that the efficiency may be lower than the enviable 7% figure, and possibly lower than the 5% of many conventional speakers. The inventor believes that efficiency may be substantially improved by increasing the size of the ion cloud chamber. It is likely that power levels as high as several hundred acoustic watts can be produced with specially designed systems.

Units have been operated for several thousand hours without effect on performance. The life span appears to be limited primarily by sputtering of electrode material onto the walls.

The cost of a basic Ionophone in mass production is expected to run as low as $0.50. In an attempt to reduce this cost, the development of a ceramic unit to be used in lieu of quartz is being considered. It should be borne in mind that the basic unit is only a minor factor, costwise, in the production of a complete loudspeaker system.

Dr. Klein's invention can look forward to a promising future. As a high impedance speaker (several megohms) in AM receivers, the Ionophone could be fed directly from a sufficiently amplified i-f stage, eliminating the need for a separate oscillator to provide the speaker's high frequency field. Of great signifi-

(*Continued on page* 88)

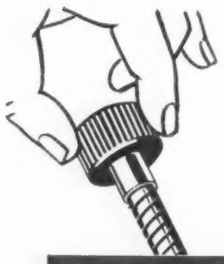
PUSH-ON SPEED NUTS® *Make New Record* FOR GRAY AUDOGRAPH

Here's how SPEED NUTS made a 50% savings in time, and a 75% material savings in the assembly of Gray AUDOGRAPH Dictating Machines . . .

Engineers at Gray Manufacturing Company took a second look at the index strip on their Audograph Machine and this is what they found. Five standard Tinnerman Push-On Type SPEED NUTS could be zipped over plain studs to attach the complete Index Strip Holder Assembly in half the time . . . replacing hex nuts, lock washers and eliminating special threaded studs.

This is just one of the many SPEED NUT Savings Stories being reported every day in a wide variety of industries. Take a second look at some of your assembly operations with an eye to keeping costs down and quality production UP; your Tinnerman representative is prepared to help. SPEED NUTS are the most economical fasteners ever developed—to prove the point, we'd like to make a comprehensive Fastening Analysis of your product line. In the meantime, write for your copy of SPEED NUT Savings Stories, TINNERMAN PRODUCTS, INC., Box 6688, Cleveland 1, Ohio. *In Canada:* Dominion Fasteners, Ltd., Hamilton. *In Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *In France:* Aerocessoires Simmonds, S. A.—7 rue Henri Barbusse, Levallois (Seine) France.

The Gray Executive Model AUDOGRAPH machine pictured here is one of a complete line of dictating and sound-writing equipment. Above, right, sketch shows how Index Strip Holder is attached with Push-On Type SPEED NUTS. 5 SPEED NUTS and studs replace 5 special threaded studs, 5 Bronze Lock Washers and 5 Brass Hex Nuts.
TINNERMAN Speed Nuts®
*Trade Mark Reg. U. S. Pat. Off.
FASTEST THING IN FASTENINGS®



How to give your equipment True Fingertip Tuning

Couple with S.S. WHITE FLEXIBLE SHAFTS

A radio and television set buyer is always on the lookout for features that increase his viewing or listening comfort and pleasure. So, it's worthwhile considering this simple, effective way of providing your equipment with a method of control which puts the tuning knobs right at his fingertips where he doesn't have to bend, stoop or squat to manipulate them.

All that's required is an S.S. White flexible shaft coupling between the tuning knobs and their respective circuit elements or switches. This allows the knobs to be placed in any desired location, regardless of the location of the elements. They can be mounted on the top, on the side, in the front or the back of the cabinet. They'll work equally well in any position, because S.S. White flexible shafts are specifically designed to give smooth, responsive control around turns or bends and over any distance.

What's more, S.S. White shafts are easy to install, require no alignment or adjustment and retain their original sensitivity throughout the life of the equipment. For further details,

WRITE FOR THIS FLEXIBLE SHAFT HANDBOOK

It contains 256 pages of facts and engineering data on flexible shaft construction, selection and application. Copy sent free if you request it on your business letterhead and mention your position.

THE S.S. White INDUSTRIAL DIVISION
DENTAL MFG. CO.
Dept. Q, 10 East 40th St.
NEW YORK 16, N. Y.

Western District Office • Times Building, Long Beach, California

cance too is the elimination of the receiver's audio amplifier and detector, the latter usually being an undesirable source of distortion. As an ultrasonic generator capable of covering a wide frequency range, the limitations of presently available single frequency units would be overcome. In such generator applications, researchers expect to encounter several obstacles in coupling to media other than the atmosphere because the ionization process takes place in air. As a variable conduction type microphone, the distortion free characteristics of the Ionophone would be a prime asset. However, the device's inherent high noise level caused by the random ion motion could be a serious detriment and would have to be drastically reduced to make this application practicable.

Other prospective applications include medical therapeutics, underwater sound detection, pressure and dielectric measurement and numerous uses which will make themselves apparent as additional performance characteristics are realized. It should be interesting to observe how the Ionophone matures from today's developmental infancy to the status of an established and practical scientific advancement.

Nonlinear Resistor

(*Continued from page* 69)

to rating the balance accuracy as "n% of full-scale."

With ordinary unselected diodes, it is difficult to secure a significant dynamic range for such a device. The curves of Fig. 5-B show the reason for this fact. One way of securing similarity between the curves is to skew the first quadrant portion of 2 to the left and the third quadrant portion of 1 upward. We see from (11) and (12), however, that this would require the addition of two negative resistances.

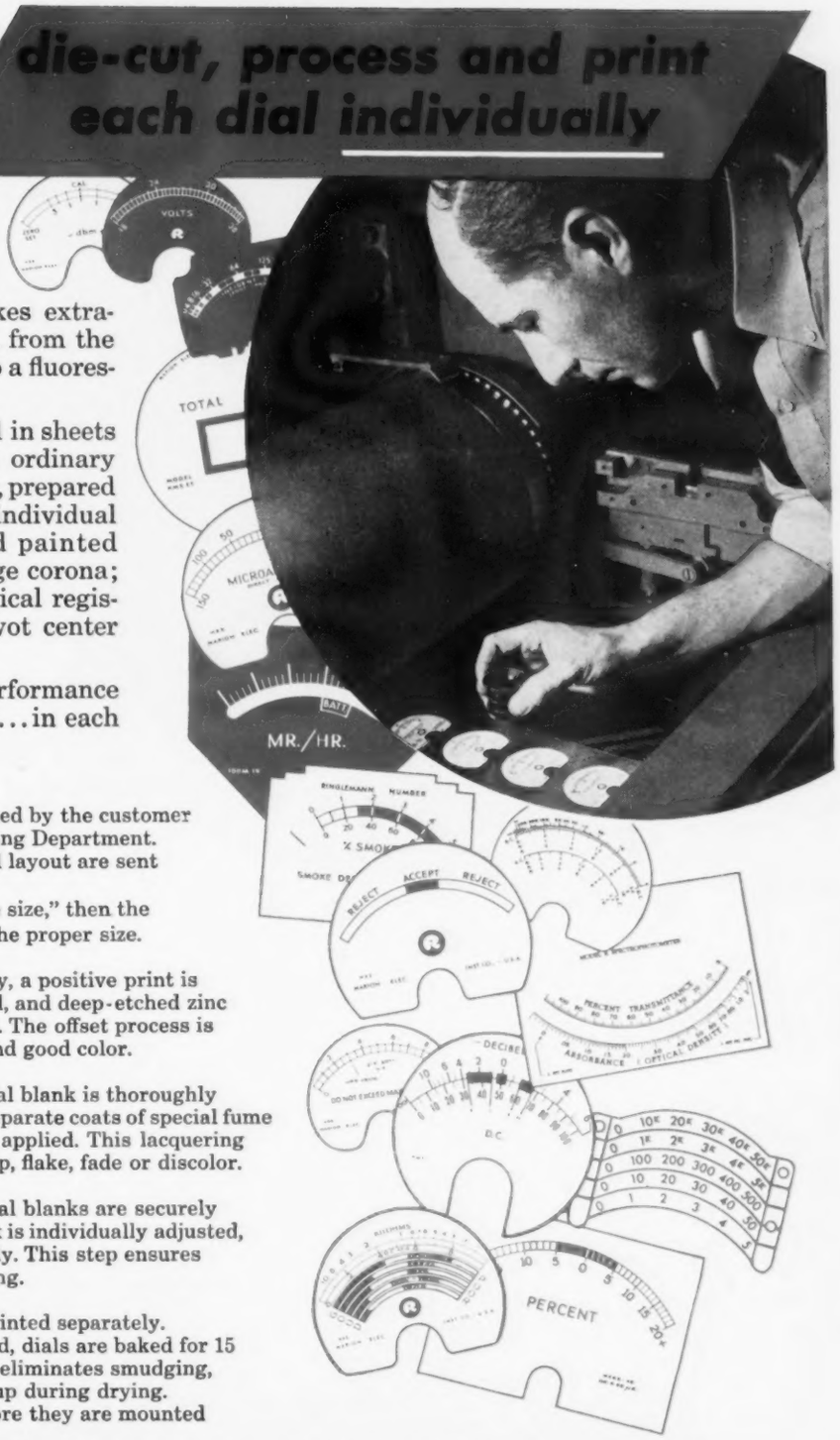
We note, however, that high rectification efficiency is less important in this problem than balance. Let us then skew the first quadrant portion of 1 to the right and the third quadrant portion of 2 downward. This operation can be performed using only simple positive resistors. If the dotted resistors indicated in Fig. 5-A are inserted, a balance adjustment may be made to secure a high dynamic range. In actual practice, such a comparator has been built using two quite dissimilar IN34 crystals. The dynamic range achieved by this technique was 72 db.

This work is supported in part by the Department of Navy, Office of Naval Research under contract NO-bs 25391, Task 7.

This paper was first presented before the National Electronics Conference in Chicago, Ill. Oct. 22-24, 1951.

marion methods

die-cut, process and print each dial individually



Because the accuracy of an indicating instrument is completely dependent upon the accuracy of its dial, Marion takes extraordinary care with each dial . . . from the simplest black and white type to a fluorescent type of seven colors.

Marion dials are never printed in sheets and then stamped out, as are ordinary dials. Each Marion dial is die-cut, prepared and printed *separately*. This individual handling guarantees finished painted edges, which reduces high voltage corona; it also assures accurate mechanical registration of the dial with the pivot center of the instrument.

Precision and dependable performance are built into every Marion dial . . . in each step of manufacture.

Preliminary Operations . . . Dial data furnished by the customer is carefully checked by Marion's Engineering Department. After Engineering OK, data and suggested layout are sent to the Art Department.

The dial scale is drawn 4 to 6 times "life size," then the drawing is photographed and reduced to the proper size.

Preparation of Plates . . . After photography, a positive print is made. Color separations are made by hand, and deep-etched zinc plates for offset lithography are produced. The offset process is used to assure sharp printing definition and good color.

Preparation of Dial Blank . . . Each metal dial blank is thoroughly rinsed and vapor de-greased. Then, three separate coats of special fume and age-proof eggshell-white lacquer are applied. This lacquering technique gives a surface that will not chip, flake, fade or discolor.

Registering . . . After careful inspection, dial blanks are securely mounted on the printing press. Each blank is individually adjusted, and the printing plate is positioned exactly. This step ensures perfect registration for multi-color printing.

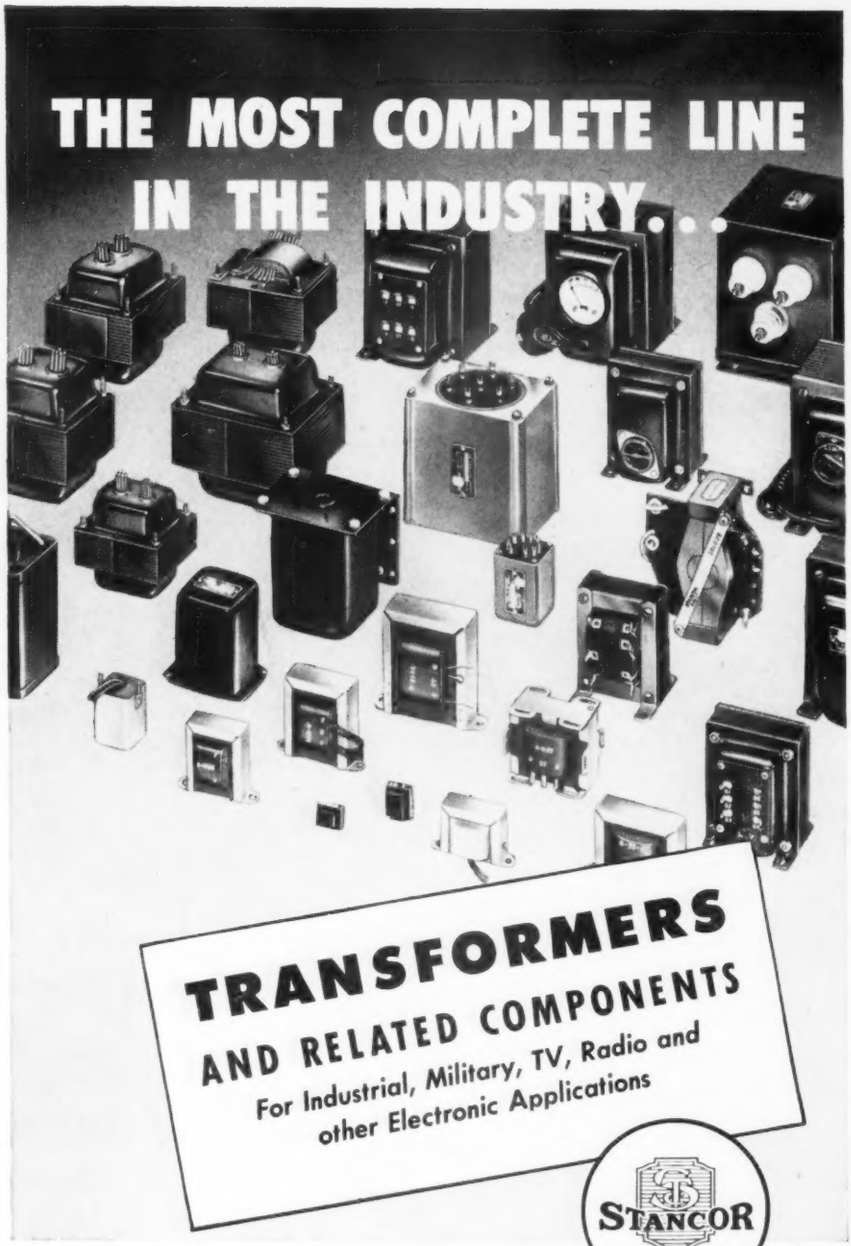
Printing and Drying . . . Each dial is then printed separately. After special inks of each color are applied, dials are baked for 15 to 20 minutes to set the ink. This process eliminates smudging, and minimizes the amount of lint picked up during drying. Dials are thoroughly inspected again before they are mounted on Marion instruments.

Other Marion Methods. Marion's method of assuring the top accuracy and service of each dial by individual handling is only one of a number of methods which Marion is presenting in the hope that some of them will help you as they have helped us. We will be pleased to send more information if desired.

MARION ELECTRICAL INSTRUMENT CO., 430 CANAL ST., MANCHESTER, N. H.

marion meters

MANUFACTURERS OF MARION (R) *uggedized* PANEL METERS



Stancor is, of course, one of the world's largest producers of special design transformers for use in all types of electronic equipment.

In addition, Stancor has the most complete stock line in the industry for use in your prototypes or lab equipment. If you need one or a hundred transformers in a hurry, you can probably find the type you need in the Stancor catalogued line. They are quickly available through the Stancor parts distributor in your locality.

The new 24 page Stancor catalog lists 475 transformer and related components. Ask your Stancor distributor for a FREE copy, or write us directly.

JUST PUBLISHED!

STANDARD TRANSFORMER CORPORATION

3572 ELSTON AVENUE, CHICAGO 18, ILLINOIS

Tape Recording

(*Continued from page* 57)

anywhere from 1,000 or 2,000 cycles on up.

Apparently, the stress which has been given to recording high frequencies has detracted somewhat from a better understanding of the problems involved in recording the opposite end of the spectrum. At a given tape speed, direct amplitude recording has a definite low frequency response limit. As wavelengths on the tape approach the physical dimensions of the head areas contacting the tape, wide excursions in level take place due to interferences set up across the gap and the outside pole pieces of the head. Furthermore, dc response is not possible with conventional direct amplitude tape recording because the output voltage of a playback head is proportioned to rate of change of flux. As a further complication, equalization circuits which are necessary to produce flat response, introduce phase distortion and seriously impair satisfactory preservation of wave shape.

It has been necessary, therefore, to resort to some form of modulated carrier system. AM carriers can be used on medium frequencies if errors of 20 to 25% can be tolerated. But where wavelengths approach 0.001 in., nodules on the tape can produce instantaneous dropouts as great as 50%.

As a solution to this problem, a special FM carrier technique for recording dc and very low frequency data was developed. Information signals from an external pickup are amplified and are used to FM a local oscillator. The carrier containing FM information is then recorded on tape. Original amplitude information is restored during playback by a demodulator so that frequencies down to dc are obtained with excellent transient response and minimum phase shift.

Signal-to-noise ratios of 45 to 50 db are possible by deviating the carrier as much as ± 50% of center frequency. With such a large ratio of peak deviation to peak flutter, very good signal-to-noise ratios can be consistently maintained. The Model 306 electronics chassis was specifically designed for this type of recording and overall response is flat within ± db from dc to 2,500 cycles.

Since the development of improved multi-track record and playback heads, many new and important applications for magnetic tape have opened up. Both FM and direct am-

(*Continued on page* 92)

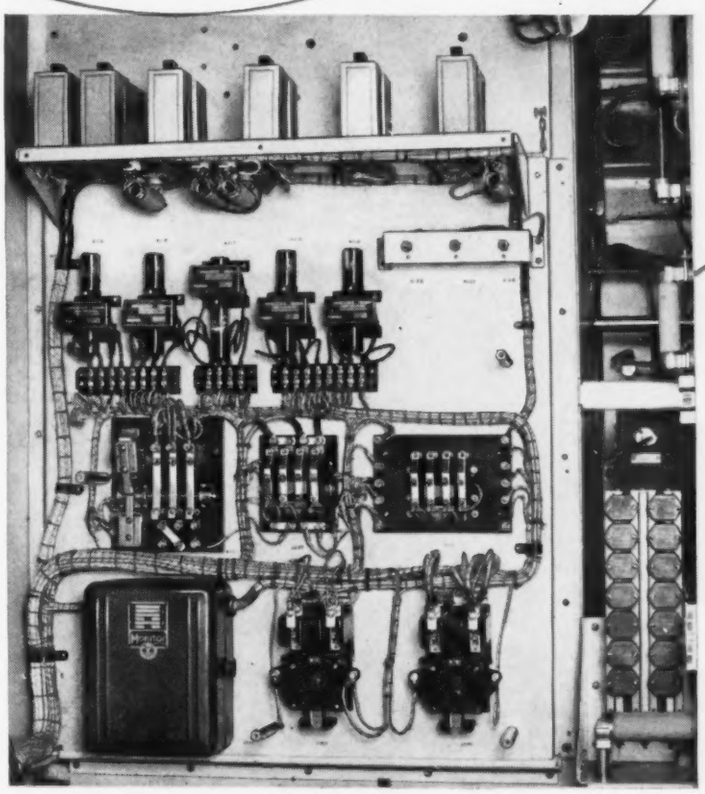
ADLAKE RELAYS AT WORK—One of a series of advertisements on specific ADLAKE applications.

Adlake
TRADE MARK

Relays Are Used in

LORAN Transmitters

Manufactured by Federal Telephone and Radio Corporation



Relay control panel of Loran Transmitter Model T-137, built by Federal Telephone and Radio Corporation. Five ADLAKE Relays are used to control plate and filament power and to provide overload protection—operations calling for the utmost stability in time delay.

Loran transmitters (LOng RAnge Navigation) are of prime importance to both naval and merchant fleets. The builder of these transmitters, Federal Telephone and Radio Corporation, Clifton, N. J., uses ADLAKE Relays—because ADLAKE assures the utmost reliability under all operating conditions.

ADLAKE Relays are designed and built to meet the most exacting requirements. Their mercury-to-mercury contact prevents burning, pitting and sticking, and their sturdy construction armors them against outside vibration or impact. And most important of all, *they require no maintenance*, for they are hermetically sealed against dust, dirt and moisture.

For the full story on the part ADLAKE Relays can play in *your* business, just drop a card to The Adams & Westlake Company, 1130 N. Michigan, Elkhart, Indiana. No obligation, of course.

Every ADLAKE Relay Gives You These Advantages:

HERMETICALLY SEALED—dust, dirt, moisture, oxidation and temperature changes can't interfere with operation.

MERCURY-TO-MERCURY CONTACT—prevents burning, pitting and sticking.

SILENT AND CHATTERLESS • ABSOLUTELY SAFE • REQUIRES NO MAINTENANCE

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Adams & Westlake
COMPANY

Established 1857 • ELKHART, INDIANA • New York • Chicago

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Because of their clean compact design, General Industries' *Smooth Power* Phonomotors are ideally suited for *any* phonograph application —portable record player, table-model combination or full-size console.

Write *today* for complete information about these trouble-free, performance-proved phonomotors, including specifications, design features and dimensions.

THE GENERAL INDUSTRIES CO.
Department MB • Elyria, Ohio

plitude type recorders of from 2 to 14 separate information tracks are new being manufactured. Ampex is also manufacturing extremely compact units of entirely new design which contain a tuning fork and an amplifier. This permits 24 v. dc or 400 cycle airborne operation without regard to a source of a stable 60 cycle supply.

Shock and Vibration

FM or dc multi-track recorders have had their greatest use in shock and vibration or seismic exploration work where a number of transducers or pickups must be accurately recorded and reproduced simultaneously. Other important uses have been found with various types of simulators.

Multi-track direct amplitude recording has many immediate applications in spectrum analysis work. High frequency information, such as may be required for jet engine studies, may be readily stored and played back as often as required through bandpass filters. Since only the relative amplitude vs. frequency characteristics are to be determined, no FM carrier system is required for this type of recording.

The third and last system under discussion concerns magnetic tape for computers. While considerable work has already been done in this field, it is believed that potential uses have hardly been explored. Considering for a moment the tremendous pulse packing which may be achieved with multi-track recording on a small area of tape, it is quite possible that this method may soon outmode or improve upon conventional types of card punch machines. With superior storage capacity, complete personnel records of large corporations, factory inventories and complete details regarding insurance policy holders may be conveniently filed away on rolls of

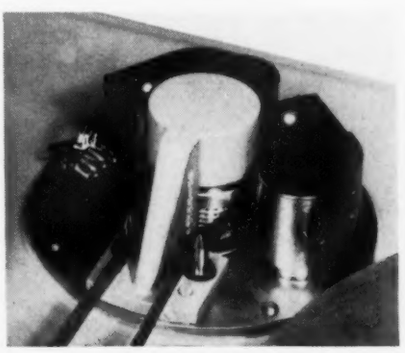
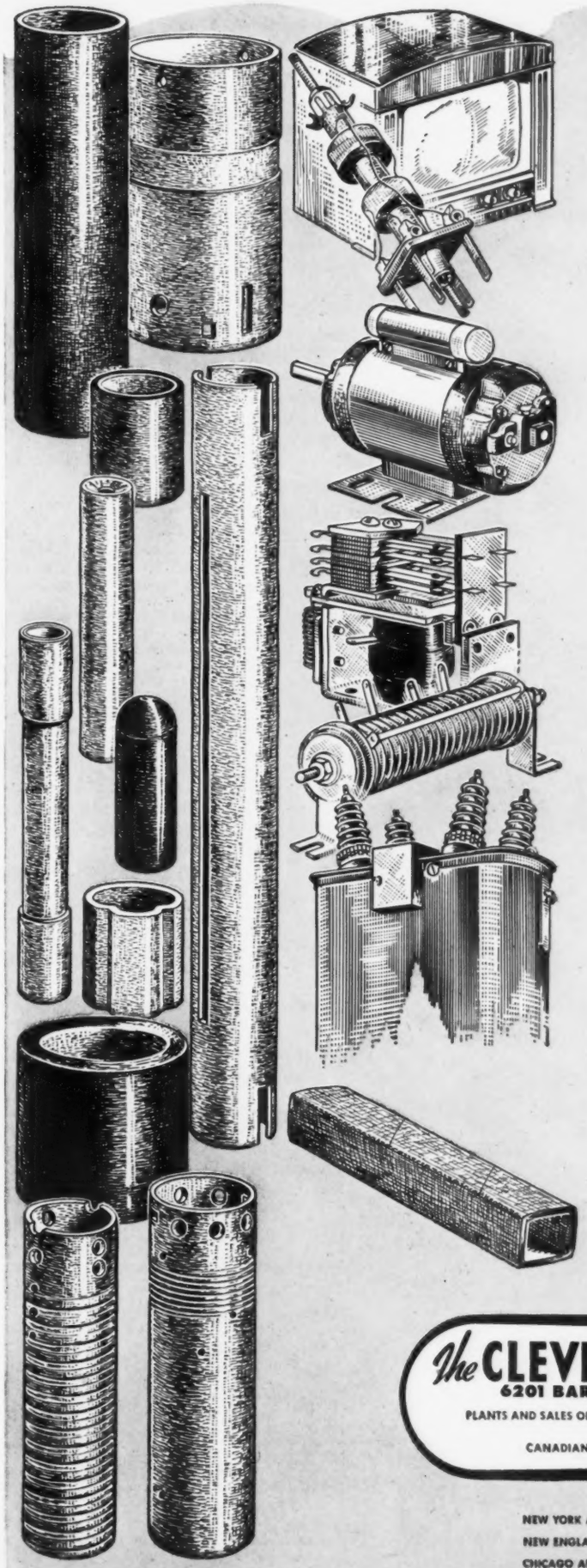


Fig. 11: Head assembly of Model 500 has large capstan perforated for vacuum which holds tape

(*Continued on page* 96)



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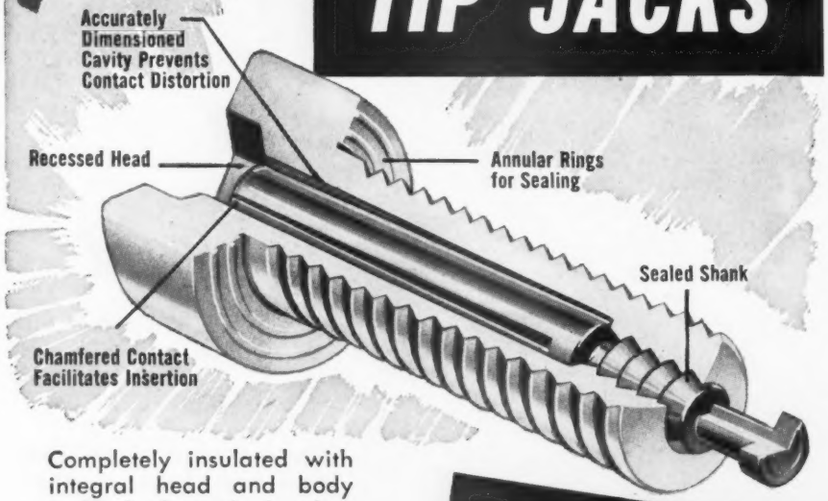
New JOHNSON NYLON TIP JACKS



Completely insulated with integral head and body molded of tough, low-loss Nylon. High breakdown voltage, low capacity to panel are characteristics of these completely new JOHNSON tip jacks.

JOHNSON Nylon Tip Jacks are furnished in eleven bright, uniform colors adapting them to coded applications. Contact is securely anchored in the jack body, recessed to avoid accidental contact. Standard contact materials are phosphor bronze and beryllium copper, both silver plated. Solder terminal is hot tin dipped. Mating plug is firmly engaged with virtually all its surface area in contact with the jack. Thus, low, stable contact resistance is assured. Jack body threaded ¼"-32, mounted by single nickel plated brass nut.

We would like to present you with samples of these outstanding jacks. Write us on your letter head requesting 105 D6.

SPECIFICATIONS

DC breakdown, 11,000 volts

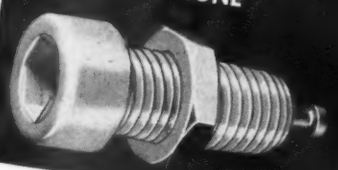
Nominal capacity to ⅛" panel, 2.0 mmf.

Mating pin, .081" diameter

Mounting hole required, 17/64"

Head diameter, ⅜"

Insulating hardware required, NONE



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105-606-1	105-606-2	Orange
105-607-1	105-607-2	Yellow
105-608-1	105-608-2	Brown
105-609-1	105-609-2	Light Green
105-610-1	105-610-2	Dark Blue
105-611-1	105-611-2	Ivory

E. F. JOHNSON CO.
WASECA, MINNESOTA

tape and played back as required.

Tape is particularly adaptable to the storage of binary code pulses. Here data reduction time may be either increased or reduced by changing the ratio of recording speed vs. playback speed. Ratios of 80 or 100 to 1 are relatively easy to accomplish with modified Model 300 top-plate assemblies.

The usual technique of recording pulses of a presence and absence type is first to convert the pulses into sharp spikes before attempting to record them on tape. This procedure is necessary to prevent pulse differentiation during later tape playback. During recording, these spiked pulses saturate the tape and are read back at reduced speeds. The Austin Co. in New York has recorded pulses in this manner and has read back information at a 40 to one speed reduction. With the tape traveling at only 0.5 ips, they were able to get better than 30 db signal-to-noise ratio. This figure has also been confirmed by several other agencies using the same technique. Furthermore, no difficulty was experienced in recording up to 600 pulses to the inch.

Magnetic tape recording is now applied to so many fields of scientific and military research that it has been quite impossible in these pages to do more than indicate with a few specific examples the new and very profound nature of this art.

The writer wishes to express his appreciation to Ampex Electrical Corp., Raymond Rosen Engineering Co., Austin Co., Raytheon Manufacturing Co., Douglas Aircraft, and Johns-Hopkins University who performed many of the studies and evaluations mentioned in this paper.

COLOR TESTS DISCUSSED

Dr. W. R. G. Baker, (center) chairman of the National Television System Committee of the RTMA and GE vice president, discusses with Peter Mole (left), president of the SMPTE and Herbert Barnett, exec. v-p of the SMPTE, the color TV field tests being conducted by the NTSC. Tests will be completed this summer.

SMOOTH ACTION

NEW

Houston-Fearless

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Camera is raised quickly, easily by lifting on steering wheel.

New smooth action... new stability... new convenience and ease of operation are offered in the new Houston-Fearless Television Camera Pedestal, Model PD-3. Camera is accurately counter-balanced, making it possible to raise and lower quickly, smoothly by simply lifting or pressing on steering wheel, even with pedestal in motion. Three pairs of dual-wheels assure smoother rolling-dolly shots. Two types of steering: for straight tracking or sharp turning. All controls are within easy reach of cameraman for maximum convenience. Dependable Houston-Fearless quality throughout. Makes possible better, more showmanlike productions in any studio. Write for details today.

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Standard Frequency

(*Continued from page* 48)

WWV, but reception occurs later. Accordingly it is useful for a shorter time than WWV (9 hours versus 15 hours for WWV in Jan.).

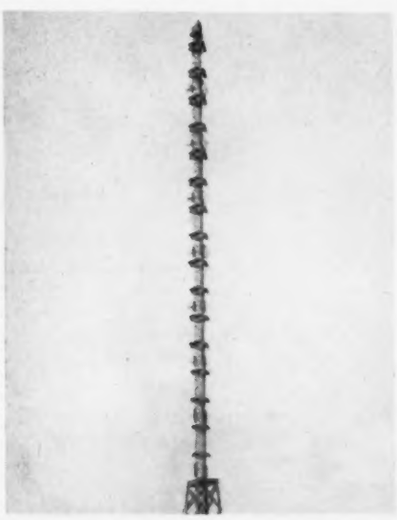
Fig. 5 shows the 10 and 15 MC reception at Anchorage. The 10 MC reception from WWVH seems to be more variable with season than that from WWV. There is a definite increase in the hours of reception of WWV beginning with June and extending until Jan., when the reception period begins to decrease. The upper curves of Fig. 5 show the 15 MC reception at Anchorage. Seasonal effects are apparent. WWVH appears to be useful for a longer period in the day than WWV.

Data from Los Angeles

An observer in Los Angeles, Cal., made a large number of observations of reception of WWVH and WWV from late March through Sept. 1950. These observations provided data except for the late evening and early morning hours. As there appeared to be very little seasonal change, all data were averaged and curves plotted for the different frequencies of WWV and WWVH against hours UT as in Fig. 6.

Part Two will appear in the July issue

NEW 316-KW VHF ANTENNA



Federal Telecommunications Labs of Nutley, N.J. has announced an 80-ft., 6400-lb. 16-bay triangular loop antenna for TV channels 7 through 13, capable of handling 316-kw erp with a power gain of 17. Complete antenna array is fed by a single transmission line, and sells for about $45,000. Also available are an associated 25-kw air-cooled amplifier which can be driven from an existing 5-kw transmitter, a vestigial sideband filter, diplexer and power supplies for both aural and visual units

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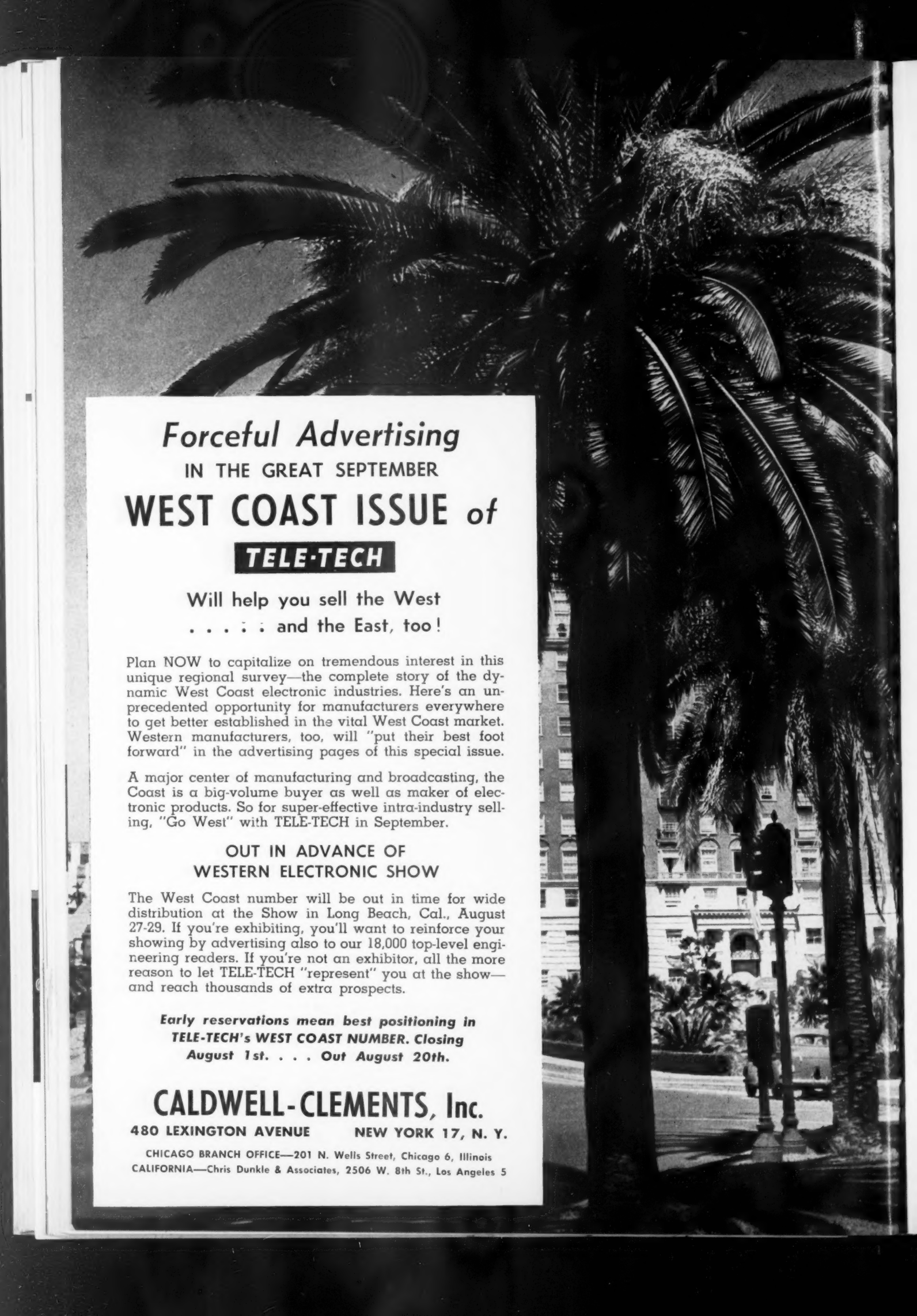

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LETTERS . . .

WOW

Editors, TELE-TECH:

We read the comments on tape recorder wow by Boothe (TELE-TECH, May, '52, p. 44) with interest. While working with one of the smaller audio firms in the East, we ran into unsuspected troubles in attempting to check wow, drift, flutter and hash effects accurately in tape transport mechanisms. For one thing, we got wide drift readings which seemed to have no direct connections with circuit or tape drive shifts. We found by means of precision vibrating-reed frequency meters that although the power line frequency averaged out to 60 cycles with considerable accuracy, it had a short-time drift of up to 3 or 4 cycles, or about 6% on occasion. This contrasts rather sharply with the small published wow figures on high-grade tape recorders. If one rigs up a tape-drive precision 60-cycle power supply, one then promptly runs into wow meter and test oscillator drift and shift due to power line voltage fluctuations, transients, and temperature shift effects. This results in false drift and wow readings. Power line transients especially cause trouble. A regulated ac supply and a temperature oven solve this readily enough.

Next, we got some phony flutter and hash readings when there plainly was no noticeable disturbance of the audio signal itself. After some fussing about, we finally tracked this down to a repetitive power line noise signal caused by an electric power machine operating within the building, which by an odd coincidence was putting out a steady noise burst with a fundamental of just about the 3 KC we were using for the wow test "carrier" signal (where the ear is most sensitive to pitch changes). A routine low-pass filter in the power line fixed this. By now we were giving birth to a bouncing baby ulcer.

Some time later, after becoming separated from this concern, the writer thought about this interesting little project and came to the conclusion that what was needed for carrying out precision wow tests, rather obviously, was an ultra-precision duplex tuning-fork oscillator-amplifier test rack. One would be a 3 KC fork channel to provide an exact and rock-stable test signal, and the other a similar 60-cycle fork plus power amplifier to supply an ac power source free of frequency drift, voltage fluctuations, transients and interfering noise pulses. The 60-cycle output could be used to power not only the tape recorder, but also the 3 KC oscillator itself and the wow meter. The test rack could incorporate the precision wow meter, of course. The incoming ac power should be regulated, preferably.

Since a wow meter is usually supposed to indicate 1%, 3% and 5% wow deviations, a battery of seven tuning forks could be set up to indicate these deviation limits precisely at the 3150, 3090, 3030, 3000, 2970, 2910 and 2850 cycle points. The 3 KC precision fork is used to set the wow meter 3 KC "carrier" mid-point setting. In short, one is in no position to check precision wow readings unless one has an exact signal and a precise method of powering the tape mechanism and calibrating the wow meter. The writer had already purchased an ultra-precision 3 KC tuning fork in vacuum-seal with a 1 PPM frequency rating and a 1 PPM per degree temperature drift characteristic, and had gone about ordering a similar 60-cycle fork, when he got involved in some biological experiments with animal magnetic, electric and infra-red sensory phenomena and had to shelve this little project. Perhaps some of the audio men might find this an interesting little item to fiddle around with and do a paper on.

TED POWELL
42 Nassau Road
Great Neck, N. Y.

Airborne Life Raft Originally Developed by Edo Corp.

Editors, TELE-TECH:

We note with interest the article in your May, 1952, issue on Page 67, covering the A-3 and A-4 rescue boats.

We wish to make a correction in the opening statement that the 30-ft. life raft was developed by Westinghouse. The boat referred to and illustrated being dropped from a B-29 aircraft is the USAF A-3 boat designed, developed, and manufactured by Edo Corporation. After delivery of a considerable quantity of these boats, the Air Force turned over one Edo-built boat to Westinghouse who in turn developed the radio control system.

ARCHIBALD M. BROWN, JR.
Vice-President,
Edo Corporation,
College Point, N. Y.

PATENT NEWS

The patents described in the following list are some of the many patents, presently available for licensing or sale, which may be of interest to TELE-TECH readers. Register numbers are those given in the Official Gazette of the Patent Office. Inquiries should be addressed to the owner of the patent rights or other party specified below. Complete copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C. for $.25 each.

Pat. 2,562,176. **Electrical Selective Control Apparatus,** July 31, 1951. System is suitable for operating remote devices or to control a radio beacon on a navigational buoy from a shore station. Apparatus responds to a sequence of signal pulses of prearranged length and spacing. (Owner) Herman H. Curry, 1514 Roswell St., Marietta, Ga. Reg. No. 46,672.

Pat. 2,557,038. **Phase Discriminator,** June 12, 1951. Device demodulates phase modulated signals, and does not require concurrent transmission of a reference wave. Train of sharp trigger pulses derived from incoming wave trip a relaxation oscillator to produce a sawtooth wave. (Owner) Karl F. Ross, 1054 Colgate Ave., Bronx 59, N. Y. Reg. No. 45,861.

Inquiries for the following patents should be addressed to Manager, Patent Dept., General Electric Co., Schenectady, N. Y.

Pat. 2,527,215. **Position-Type Telemeter Transmitter,** Oct. 24, 1950. Device comprises three parallel conducting plates, the center plate being divided into three insulated sectors. Dielectric between plates is mounted on rotatable shaft. Voltage is applied between outer plates. Reg. No. 40,340.

Pat. 2,528,241. **Frequency Controllable Magnetron,** Oct. 31, 1950. Two or more magnetrons are coupled so that one acts as conventional oscillator while other behaves like variable impedance. System may be used to compensate for undesirable frequency fluctuations or to provide FM. Reg. No. 40,347.

Pat. 2,528,248. **Wide Band Flexible Section for Wave Guides,** Oct. 31, 1950. Flexible section for hollow rectangular guide comprises plurality of rigid metal discs and collars, effecting reflectionless transmission. Reg. No. 40,348.

Pat. 2,529,172. **Pulse Discriminating Circuits,** Nov. 7, 1950. Transient oscillations resulting from application of a steep wave front to a damped oscillatory circuit are utilized to differentiate between pulses of different time durations. Reg. No. 40,350.

Coming Events

June 23-27—AIEE Summer Meeting, Hotel Nicolet, Minneapolis, Minn.

August 19-22—1952 APCO Conference, Hotel Whitcomb, San Francisco, Calif.

August 27-29—Western Electronic Show & Convention, WCEMA and IRE, Long Beach, Calif.

September 8-12—ISA, 7th National Instrument Conference and exhibition, Cleveland Auditorium, Cleveland, Ohio.

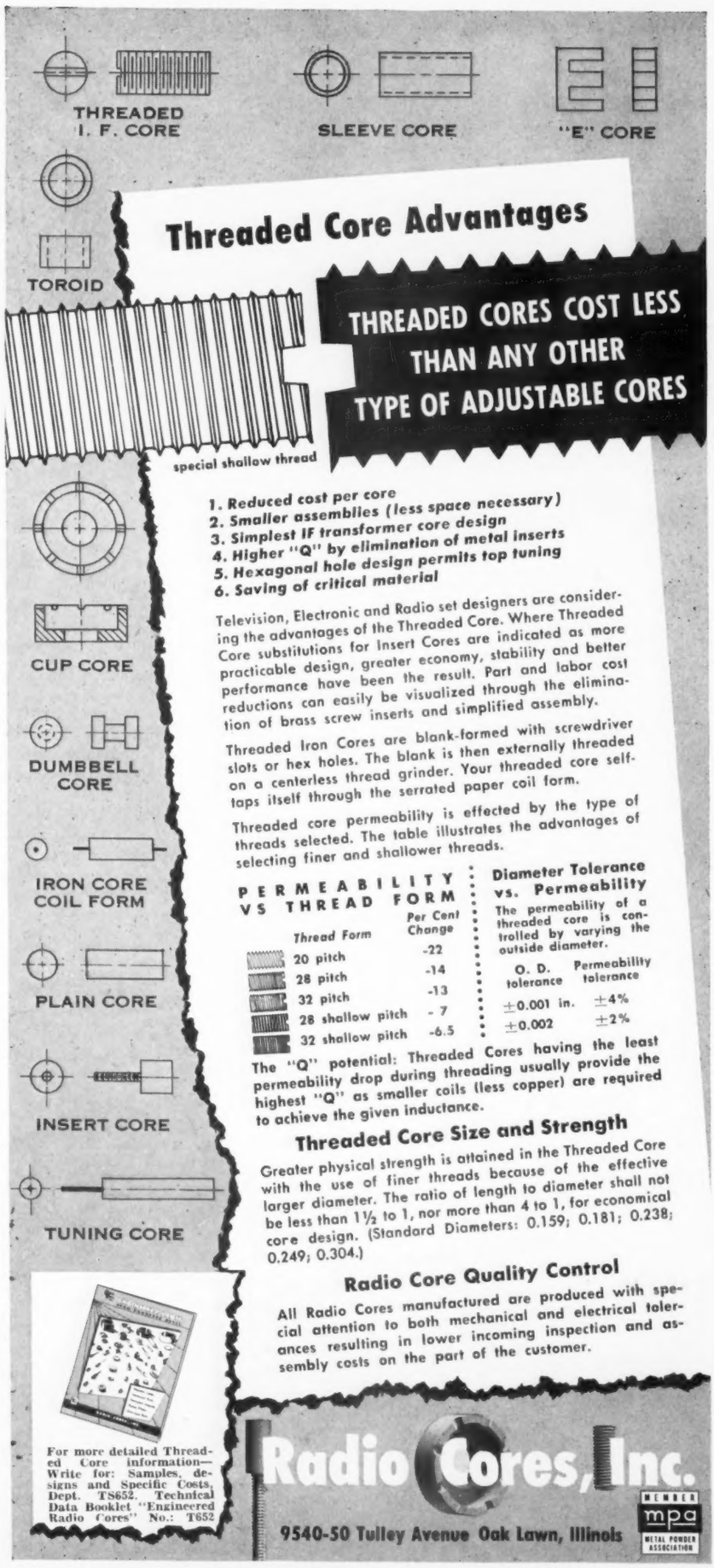
September 22-25—NEDA, 3rd National Convention, Ambassador Hotel, Atlantic City, N. J.

September 29-October 1—Eighth National Electronics Conference and Exhibition, Sherman Hotel, Chicago, Ill.

October 5-10—SMPTE, 72nd Convention, Hotel Statler, Washington, D. C.

October 21-23—1952 RTMA-IRE Fall Meeting, Syracuse, N. Y.

AIEE: Amer. Institute of Elec. Engineers.
APCO: Associated Police Communication Officers
IRE: Institute of Radio Engineers
ISA: Instrument Society of America
NEDA: Nat'l. Electronic Distr. Assoc.
RTMA: Radio-Television Mfrs. Assn.
SMPTE: Soc. of Motion Picture and TV Engineers
WCEMA: West Coast Electronic Mfrs. Assn.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Threaded core permeability is effected by the type of threads selected. The table illustrates the advantages of selecting finer and shallower threads.
PERMEABILITY VS THREAD FORM
Thread Form
Per Cent Change
20 pitch -22
28 pitch -14
32 pitch -13
28 shallow pitch -7
32 shallow pitch -6.5
Diameter Tolerance vs. Permeability
The permeability of a threaded core is controlled by varying the outside diameter.
O. D. tolerance
Permeability tolerance
±0.001 in. ±4%
±0.002 ±2%
The "Q" potential: Threaded Cores having the least permeability drop during threading usually provide the highest "Q" as smaller coils (less copper) are required to achieve the given inductance.
Threaded Core Size and Strength
Greater physical strength is attained in the Threaded Core with the use of finer threads because of the effective larger diameter. The ratio of length to diameter shall not be less than 1½ to 1, nor more than 4 to 1, for economical core design. (Standard Diameters: 0.159; 0.181; 0.238; 0.249; 0.304.)
Radio Core Quality Control
All Radio Cores manufactured are produced with special attention to both mechanical and electrical tolerances resulting in lower incoming inspection and assembly costs on the part of the customer.
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Radio Cores, Inc.
9540-50 Tulley Avenue Oak Lawn, Illinois
MEMBER mpa METAL POWDER ASSOCIATION

Helicopter

(*Continued from page* 65)

measurements such as are illustrated in Fig. 6. This is a ground mobile recording taken over a radial course of approximately 2 mi. in relatively flat terrain and at a frequency of 175 MC. It was recorded with a logarithmic compression circuit. Field intensity variations in excess of 35 to 1 are represented here.

As previously mentioned, preflight calculations indicated that severe ground reflections would be encountered at distances greater than about 2 mi. from the transmitting antenna. The effect of

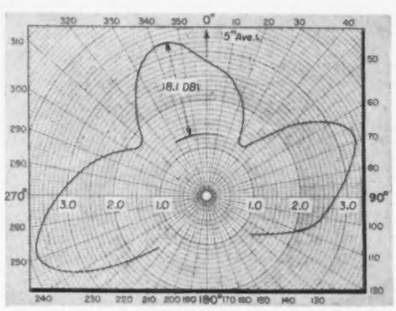


Fig. 8: Initial horizontal pattern of WJZ-TV

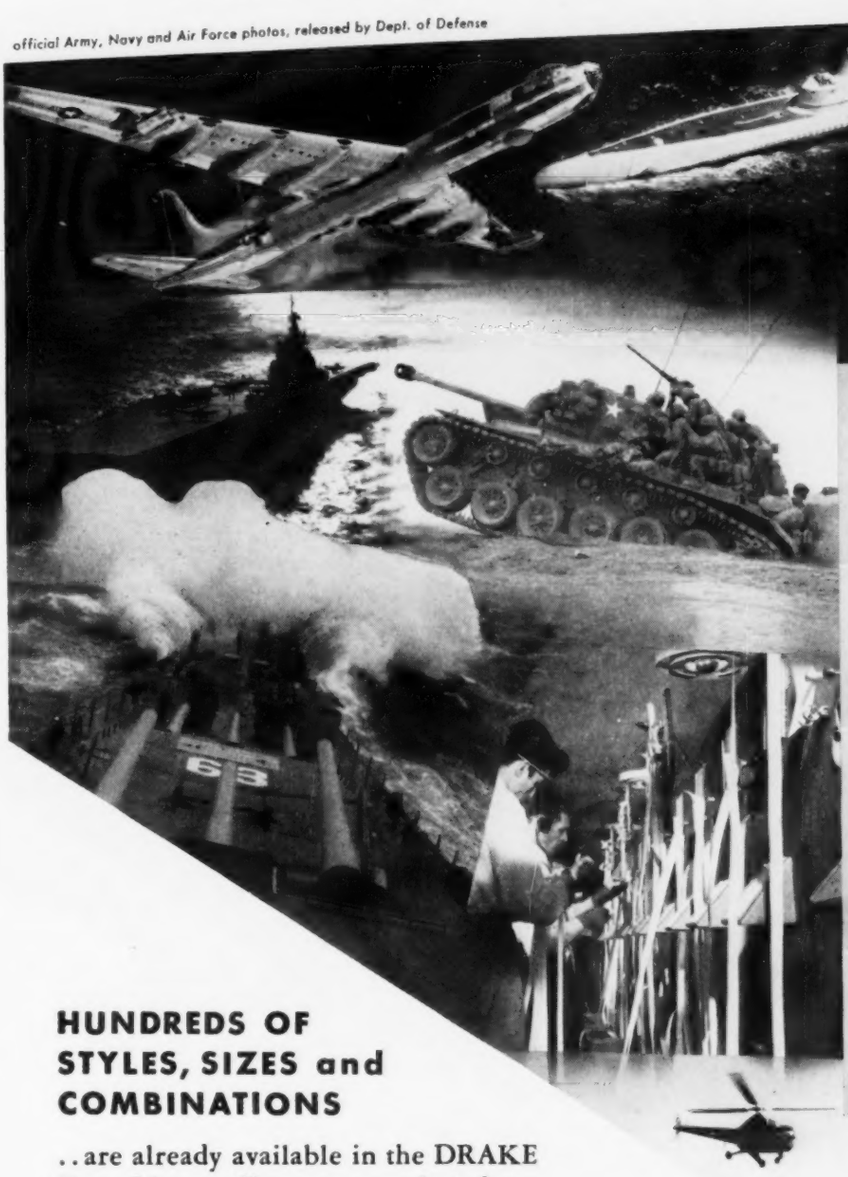
ground reflections is clearly shown on the left hand recording in Fig. 5. This recording was made by helicopter at a distance of about 3.5 mi. from the transmitter and at a 1425 ft. flight altitude. The right hand recording shown in Fig. 5 was taken over a part of the circular flight course at the 1.4 mi. radius around the Empire State Bldg. Of particular interest is the fact that this was recorded in linear, that is, without use of the logarithmic compression circuit.

Fig. 7 shows another sample of recording taken over an arc of about 90° of the circular course. It will be noted that the recording is extremely smooth and is relatively free from the severe and rapid fluctuations which might have taken place had strong ground reflected signals been present. The absence of any noticeable bouncing or rocking of the helicopter, even in gusty winds, together with excellent piloting of the ship, undoubtedly contributed to the smooth character of the recordings. The position of the helicopter in azimuth was determined by reference to the coded markings across the top margin of the recordings. These markings, corresponding with prominent ground check points below the aircraft, were placed on the records by a marker pen, electrically controlled from the cockpit of the helicopter.

(*Continued on page* 104)

★ *meeting* **JAN** *specifications* ★ ★ ★

official Army, Navy and Air Force photos, released by Dept. of Defense



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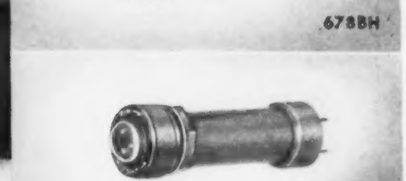

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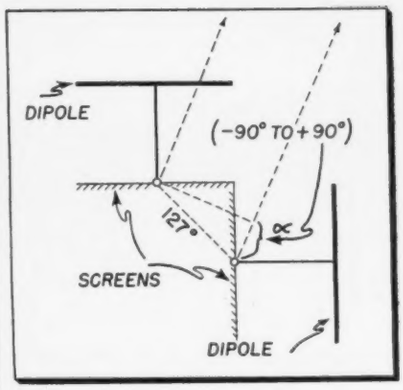

Fig. 9: Two adjacent reflectors and dipoles

The gradual dip near the center of the recording shown on Fig. 7 resulted from one of the rather deep nulls which were found in the horizontal radiation pattern of the antenna.

In the first series of measurements of the WJZ-TV antenna, four trips were made around the course. Only one hour of flying time was required for this work, including flight time to and from Teterboro Airport 6.5 mi. from Manhattan.

On Fig. 8 is a polar graph of the horizontal field intensity pattern of the antenna as measured. This graph is in terms of relative voltage and is a plot of point by point averages of the data from the four flights around the antenna. Zero azimuth on this graph corresponds to a line up Fifth Ave. The lobes at 65° and 250° are in directions where the flight course was largely over water

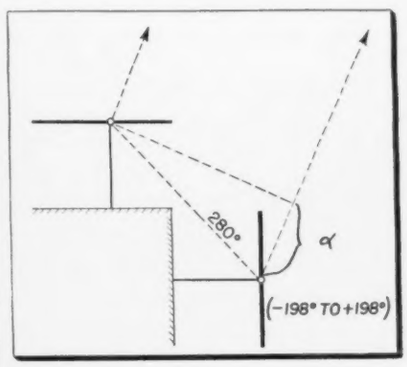

Fig. 10: Revised radiation source assumption

and where the 1.4 mi. radius may not have been maintained accurately. The data at 130°, 220° and in the sector from 305° to 55° were taken over land check points and are considered to be of good accuracy.

The field intensity variation between the lobe at 345° and the null at 35° is 8.1 db. This variation was considered to be excessive for good

(*Continued on page* 106)

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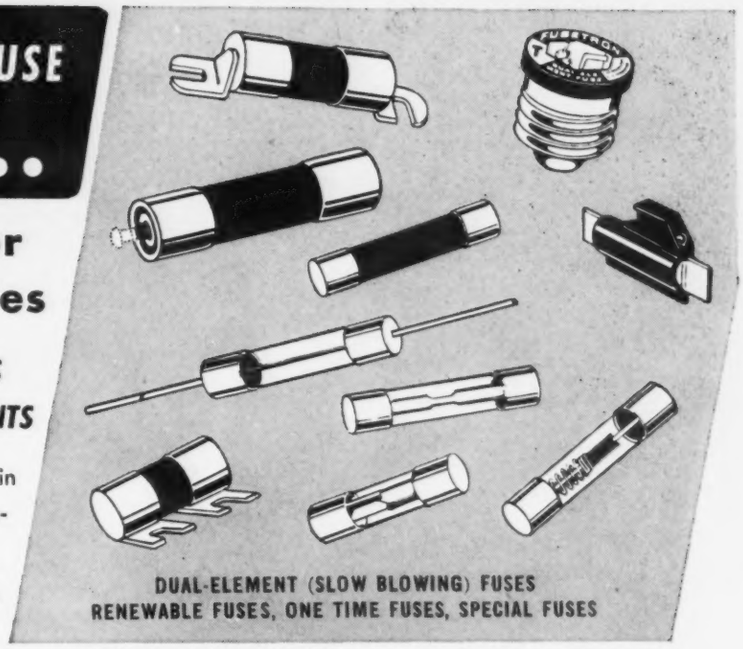

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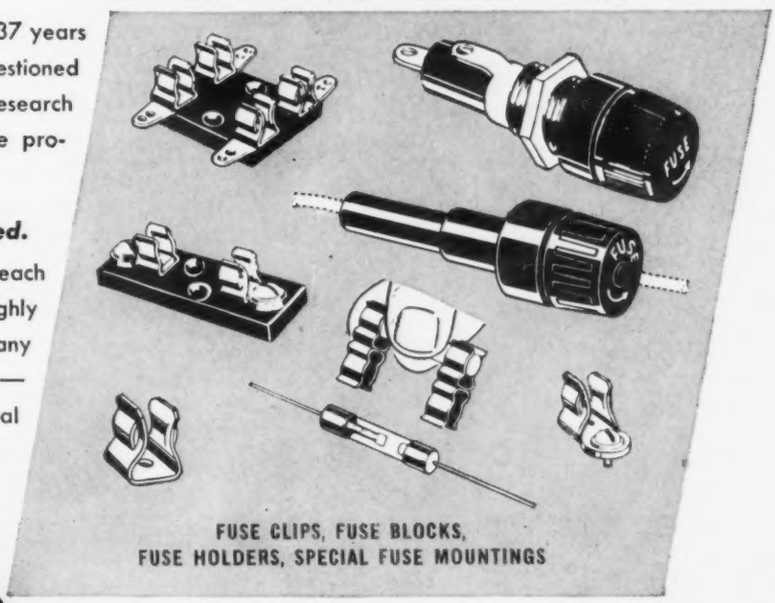

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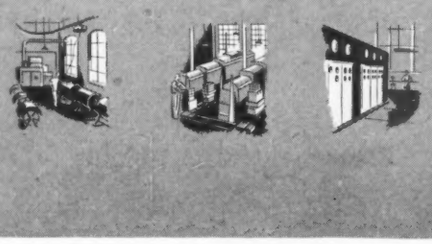

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operating practice. Incidentally, the 305° and 35° nulls lie in general directions where prior ground measurements had indicated abnormally low fields. On the other hand, the rms value of the measured pattern, in absolute terms, was within 10% of the calculated theoretical free space field intensity. This verified the normal power efficiency of the antenna system.

The WJZ-TV antenna is an array of six vertically stacked sections, each of which comprise four dipole and screen reflector assemblies mounted on the faces of a square tower. At the time of the first series of these helicopter measurements, the antenna feed system was connected for 90° progressive time phasing of the array—that is, the North radiators lead the East by 90°, the West radiators lead the North by 90° and so on around the array. In

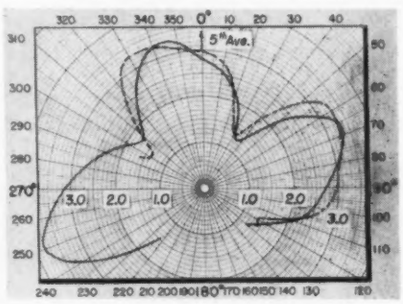


Fig. 11: Patterns using revised assumptions. Solid line is measured, dashed line computed

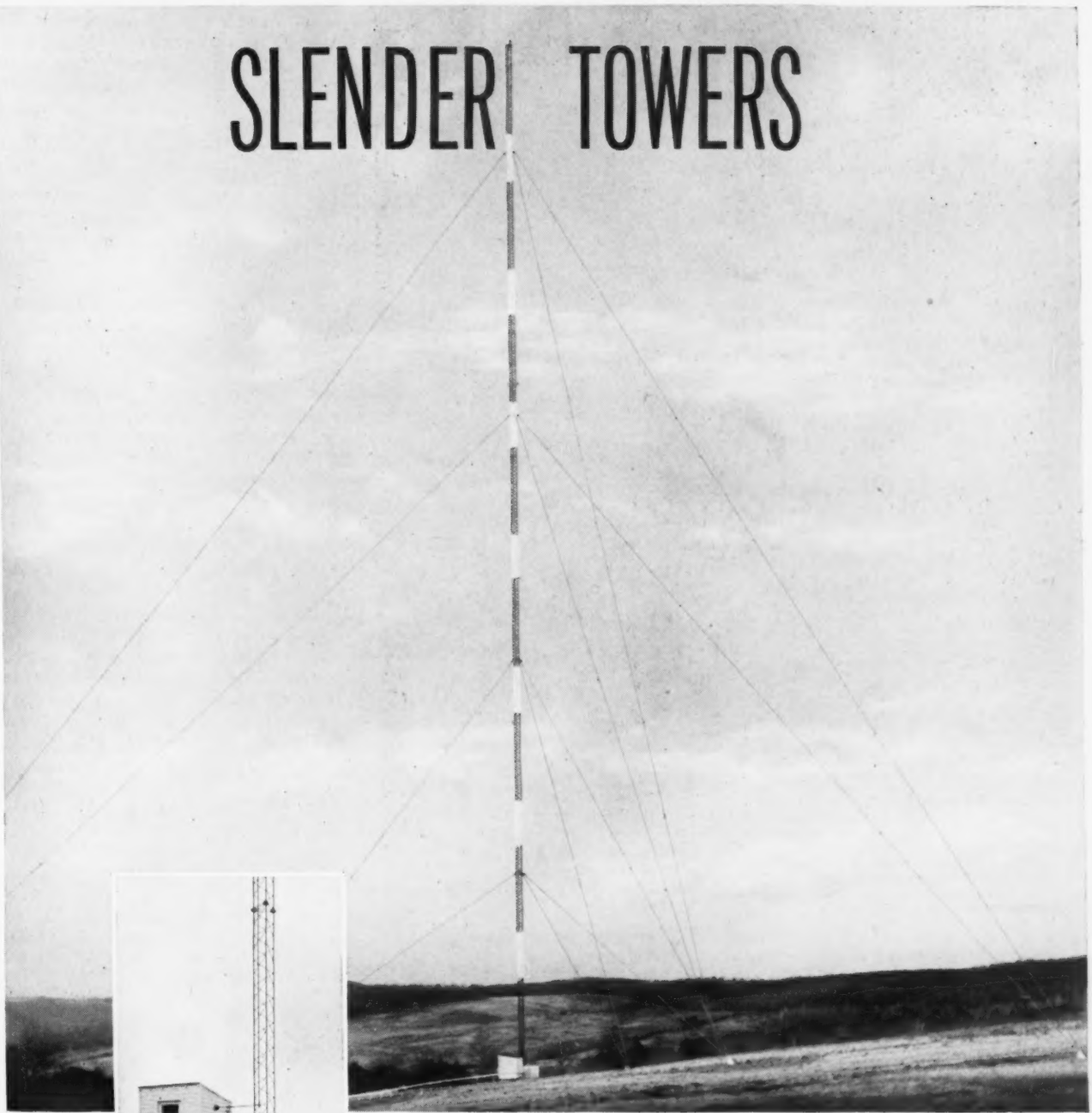
computing the horizontal pattern of this array, using the classical assumptions, one would have expected the maximum horizontal field intensity variation from lobes to nulls to be in the order of 4 db rather than 8 db as measured. Since we were completely confident of the validity of the helicopter measurements, we set out to find a theoretical approach which would bring the computed pattern into agreement with the measured pattern.

One of the classical assumptions heretofore used in computing the pattern of an array of this type is the assumption that the source of radiation from a dipole-screen reflector assembly is at the center of the reflector. As will be seen in a moment, the effect of this assumption appears to be most important.

Fig. 9 shows a plan view of two adjacent screen reflector and dipole assemblies such as are used in the type of antenna array under discussion. The centers of the screen reflectors are seperated physically by 127 electrical degrees. In a given direction of azimuth as indicated by

(*Continued on page* 108)

SLENDER TOWERS



but oh so strong

Rising straight and slim to a height of 400 feet, this Truscon "GW" Uniform Cross Section Guyed Tower typifies the engineering and structural strength built into Truscon towers. Designed for Radio Station WINR at Binghamton, New York, this steel spire, one of a three tower directional array, serves to broadcast over a large civic and rural area of the state.

Truscon possesses many years of engineering knowledge and experience in the steel AM-FM-TV-MICROWAVE tower field. Truscon facilities for the complete design and production of steel towers are modern and efficient.

Your phone call or letter to any convenient Truscon district office, or to our home office in Youngstown, will bring you prompt, capable engineering assistance on your tower problems. Call or write today.

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PROBLEM:
How to produce fine-quality tape recorders at low cost ?
SOLUTION:
Specify the New SHURE TR16 low cost magnetic recording head for record and playback!
Model TR16
1

Now available for the first time to the manufacturers of tape recording equipment—the TR16 tape-head provides fine quality at exceptionally low cost. This means that you can provide your customers with excellent reproduction in even your lowest-priced models. The TR16 is designed for general recording-reproducing, pre-recorded tape, and dictating machines.

The TR16 is the result of almost five years experience in the development of mass production-line techniques for the manufacturing of magnetic recording heads. Coupling amazingly low cost with high-quality performance, the TR16 is outstanding in the field of tape recording. Listed below are the unique features of this magnetic recording-playback head:

★

NEW TE2 MAGNETIC ERASE HEAD
No less outstanding in its contribution to low cost fine-quality tape-recording is the new Shure erase head, Model TE2.

SPECIAL FEATURES:

1. Low cost.
2. High quality—excellent frequency response.
3. Compactness. The TR16 is only .765" wide by .845" long by .609" thick.
4. Precision-controlled track width may be furnished with a track of from .025 to .100 inches.
5. Flexibility of mounting provides low cost production assembly.
6. May be used for multiple-track applications.
7. Pin-type terminals provide assembly convenience and easy replacement.
8. Utilizes famous Shure "overlapped pole-piece" construction.
9. Mu-Metal shield provides very effective hum reduction.

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the two arrows, the paths from the two reflectors to a distant point differ in length. This path difference results in a space phase angle, alpha (α), between the two fields which might arrive at the distant point from these reflectors. The actual field intensity at the distant point is, of course, the resultant of the vector combination of the fields from the adjacent antenna elements and is, therefore, affected by the space phase angle. Unfortunately, the space phase angle varies rapidly with azimuth angle. In the case illustrated, it varies between $-90°$ and $+90°$ through only one quadrant of azimuth. This varying space phase angle is a major cause of nulls in an array's horizontal pattern.

Having found by measurements deeper nulls than would be expected from computations, it is logical to re-examine the classical assumption bearing directly on space phase angle variation, this being the assumption that the center of the reflector is the source of radiation from a dipole—reflector antenna element. In an unpublished paper prepared by a well known antenna research engineer, it was reported that the source of radiation from this type antenna element is not at the reflector center but rather is more nearly at the dipole center.

On the dipole center basis, illustrated by Fig. 10, the radiation centers are physically separated by 280° and the space phase angle goes through the much larger excursion from $-198°$ to $+198°$ within a

(*Continued on page* 110)

Fig. 12: Patterns after alterations indicated adjustment error which was quickly corrected

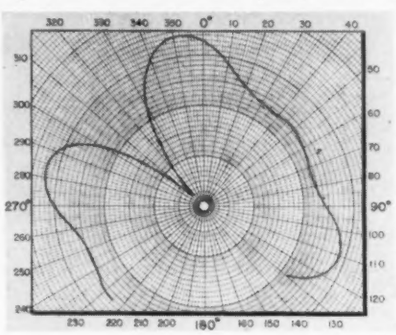
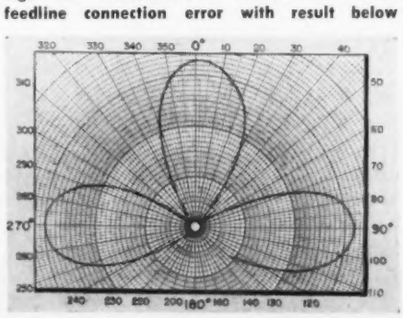
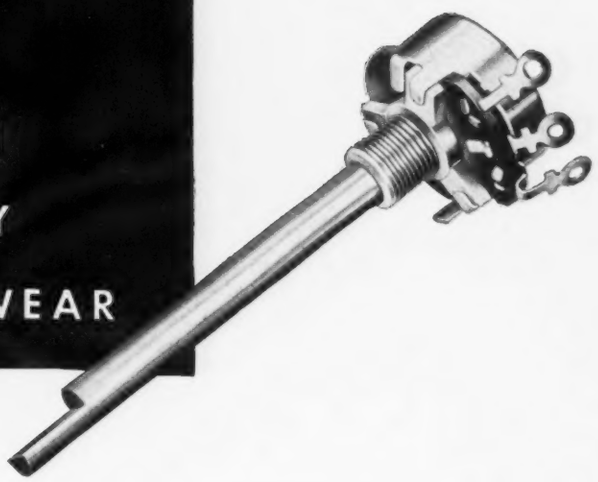


Fig. 13: Misunderstood instructions caused feedline connection error with result below



MOISTURE
FUNGUS
VIBRATION
SALT SPRAY
ROTATIONAL WEAR



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LONGER ROTATIONAL LIFE: hard nickel silver contacts limit wear, assure long service.

For special service, these additional features can be supplied:

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VIBRATION-PROOFING: lock-type split bushing prevents shaft rotation even under heavy vibration.

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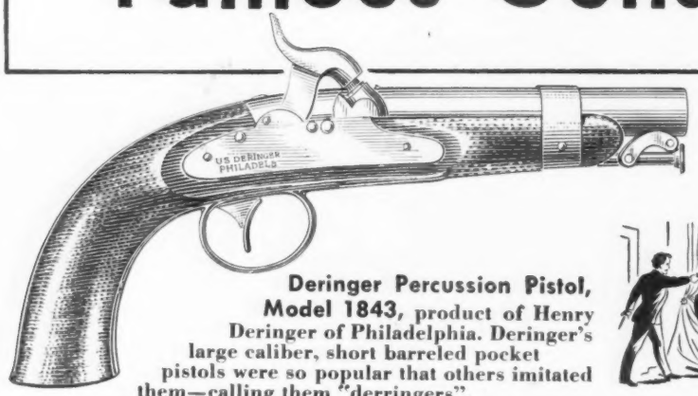
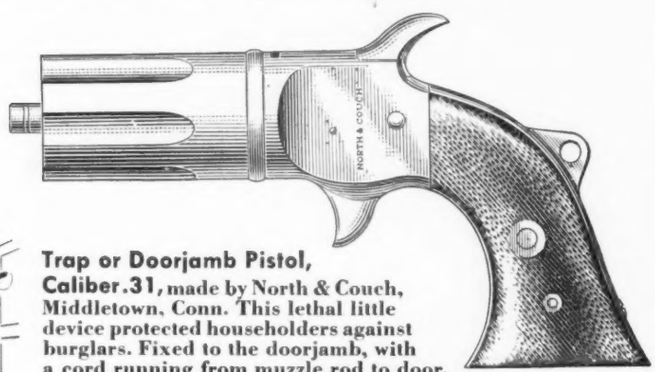
Famous Guns



Deringer Percussion Pistol, Model 1843, product of Henry Deringer of Philadelphia. Deringer's large caliber, short barreled pocket pistols were so popular that others imitated them—calling them "derringers". John Wilkes Booth used a Deringer to assassinate Lincoln.



Trap or Doorjamb Pistol, Caliber .31, made by North & Couch, Middletown, Conn. This lethal little device protected householders against burglars. Fixed to the doorjamb, with a cord running from muzzle rod to door, the pistol fired all its barrels into any intruder.

Weller Instant-heating Soldering Gun for light or heavy work. Dual heat greatly increases tip life. Switch instantly to high or low heat as job requires. Pre-focused spotlights end "blind soldering". Exclusive tip-fastening arrangement assures full, constant heat. High-impact plastic housing. Perfect balance. Low-cost replaceable tips. Pays for itself in a few months. See at your Distributor or write for Bulletin direct.

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quadrant of azimuth. This greater variation would cause deeper nulls. Recomputation of the pattern using this new assumption disclosed good correlation between the measured and computed patterns, particularly with respect to lobe to null field ratios. In Fig. 11, the solid line shows the measured pattern; the dashed line, the new computed pattern.

Maximum 3 db Variation

Further computations indicated that the feeding of all antenna elements in-phase rather than in 90° progressive phasing would result in a horizontal pattern having a maximum of 3 db variation between lobes and nulls. In this array, the in-phase feed can be readily accomplished by interchanging certain feed cables between the two antenna junction boxes and by insertion of a new phasing section in one of the two transmission lines between the transmitter and the antenna. These changes were made one night and the pattern was measured by helicopter early the next morning. This measured pattern is shown on Fig. 12. As you can see, it was not only surprising but also embarrassing. It seemed possible that the new phasing section had been inserted in the wrong line. The section was quickly changed and the pattern was again measured by helicopter. Fig. 13 shows the measured pattern which was obtained this time—obviously still more embarrassing. Within an hour after the start of the second measuring flight, it was found possible to deduce that the antenna feedline interchange had been done incorrectly due to misunderstanding of instructions and to deduce just how the connections had been made. A physical check of the connections verified the analysis. This incident is related to emphasize the speed and accuracy of pattern measurements by helicopter. Less than two hours elapsed from the start of the first

(*Continued on page* 112)

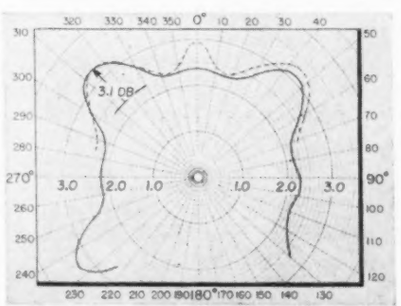
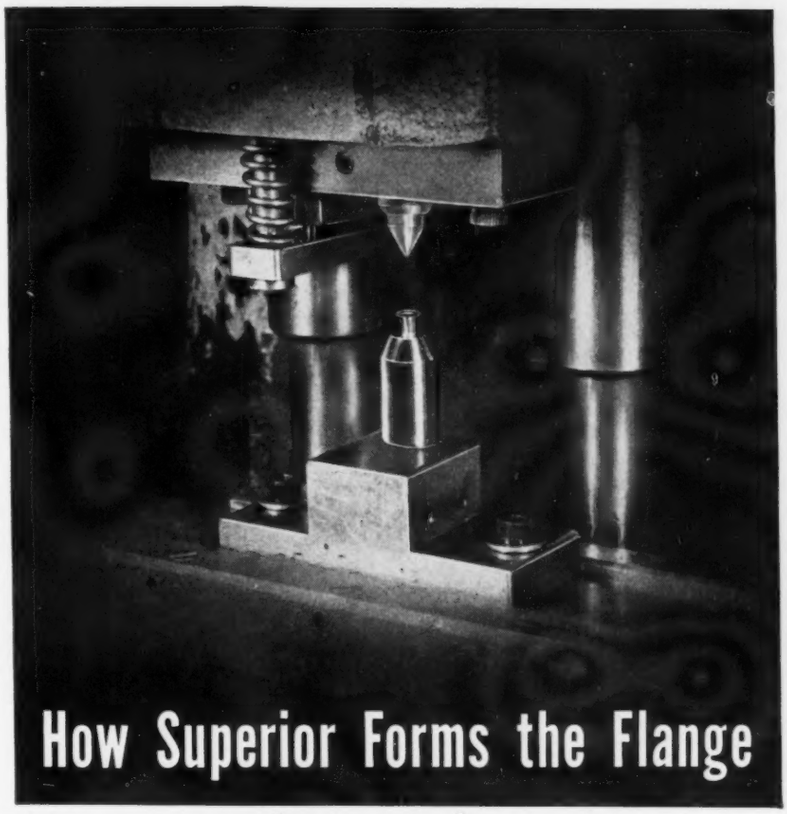


Fig. 14: Proper connection resulted in vastly improved pattern, essentially circular in shape. Solid line is measured, dashed computed



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Certainly you expect that the over-all dimensions of the part will be within certain close tolerances. You expect that the flange or flare will be the only distortion in the tube. You want the flange dimensions and the flare angle to be within the limits established in your specification. You must be assured that the worked areas will be free from cracks, pits and breaks. You probably hope that the working has not set up unrelieved stresses to result in premature failure of the part.

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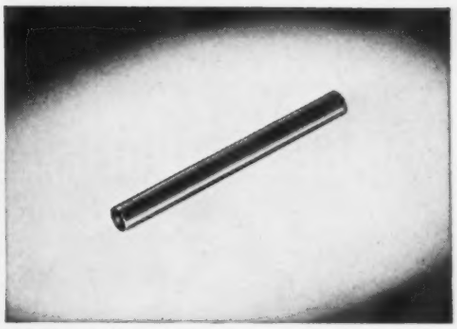

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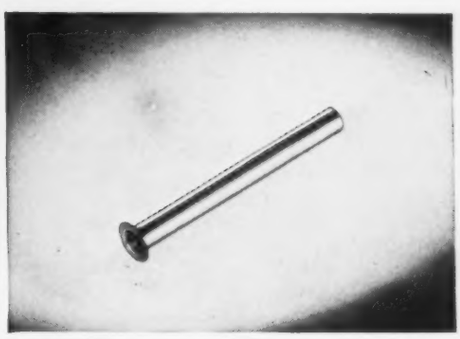

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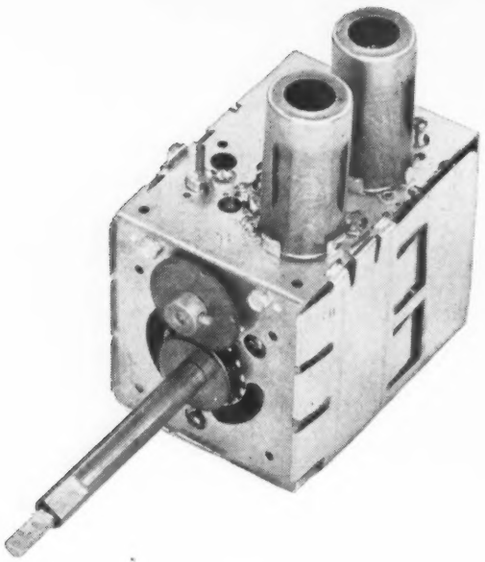
TARZIAN TUNER, Model TT-7



The Model TT-7 features 12 VHF channels plus 1 or 2 UHF inputs with appropriate UHF power switching built in. Available for 41 mc. IF systems. (Can be supplied for 21 mc. IF systems.)

SPECIFICATIONS:

RF AMPLIFIER:	6BQ7
OSC. MIXER:	6X8
POWER SUPPLY:	135 volts at 10 ma. 250 volts at 14 ma. 6.3 volts at 0.85 amps.
GAIN:	Into a 5 mc. 6 db △ f IF grid— High channels 23 db min. Low channels 26 db min.
NOISE FACTOR:	As measured into a 3.0 to 3.5 mc. △ f IF— 9.5 db max. for high channels 8.0 db max. for low channels
IMAGE REJECTION:	40 db min. high channels 46 db min. low channels
IF REJECTION:	50 db min.*
RF BALANCE:	20 db min.
VERNIER RANGE:	Plus or minus 1 mc. min. Plus or minus 2 mc. max.

* Except channels 2-3 and 4 of 41 mc. tuners.

* In the UHF position, the tuner is changed to an amplifier for the UHF I.F. Power is applied to the UHF tuner which may be either a FULL-RANGE CONTINUOUS TUNER or a single channel UHF tuner. In either case, a separate UHF antenna input is provided.

SARKES TARZIAN, Inc.

Tuner Division

Bloomington, Indiana

measuring flight that morning until the feedline connection error had been correctly diagnosed.

Antenna Feed Lines

The antenna feed lines were quickly reconnected in the correct manner for in-phase feed. The pattern of the in-phase antenna was measured by helicopter. The measured and computed patterns are shown on Fig. 14, the measured pattern by solid line and the computed by dashed line. The measured pattern does not deviate from circular by more than approximately 3 db.

To again emphasize the speed and accuracy of helicopter measurements—the work related above took place within a period of only twenty days, between Nov. 20 and Dec. 10, 1951. It could have been done more quickly had not bad weather prevented flying on a number of days during that period.

Printed Assemblies

(*Continued from page* 40)

a "puzzleboard," Fig. 4, was created. This consists of a harness made up of all the circuit elements involved, connected at the high potential end only by long flexible hookup wire. The starting point is the conventional breadboard circuit separate from any chassis. This is used as a fluid three-dimensional model, in which the free ground ends of the components permit rapid manipulation to the simplest layout. Use of the puzzleboard permits both development and design of printed circuits to proceed at a rate comparable with standard chassis layout.

The circuit and a layout for an etched 25 MC i-f stage is shown in Fig. 5. Provision has been made for feed-through busbars for heater, B+ and agc. Jump connections from the centers of the coils are unavoidable, but all other crossovers have been eliminated by relegating this function to the resistors and capacitors.

Silk Screening

In order to have a fully printed module retaining the advantages inherent in the etched deck, silk screening has been employed to produce an RC unit on a high dielectric plate (Fig. 8). This unit is fabricated on material with a dielectric constant of 4,000 and thickness 0.05 in. The material used exhibits a rather high temperature coefficient; the dielectric constant at 85°C being approximately double the

(*Continued on page* 114)

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JAMES KNIGHTS

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FREQUENCY & MODULATION MONITOR

The JK FD-12 monitors any four frequencies anywhere between 25 mc and 175 mc, checking both frequency deviation and amount of modulation. A truly precise instrument for communication systems!

When used for different bands, plug-in type antenna coils provided. Crystal accuracy guaranteed to be ± .0015% over range of 15° to 50° C. Meets or exceeds FCC requirements.

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QUARTZ CRYSTALS

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Well known to every communications man is the famous JK Stabilized H-17, with a frequency range of 200 kc to 100 mc. But this is just one crystal in the JK line. Write for complete crystal catalog!

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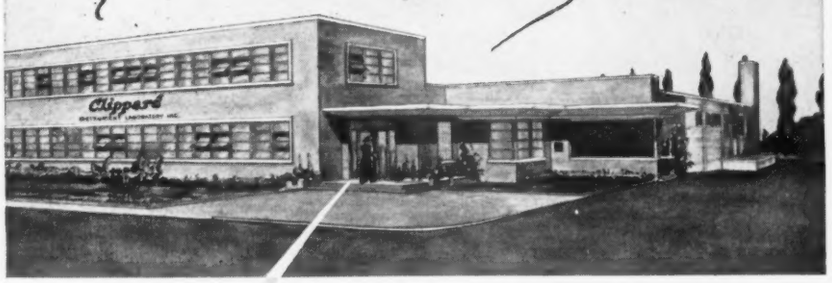

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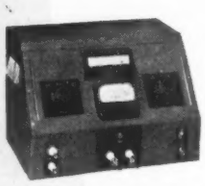
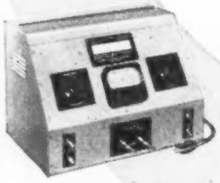


PR-5 RESISTANCE COMPARATOR permits unskilled operator to test, grade, match up to 30 resistors per minute!



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value at 25°C, with the "Curie" inflection falling at 74°C. However, this material is adequate to nearly all bypassing and coupling functions. In the card shown for a 2nd video i-f stage there are a 0.001 μf heater bypass and two 0.005 μf bypass capacitors for cathode and screen. The capacity areas on the face of the ceramic as well as all connective wiring have been produced by silk screen stencilling with conductive silver ceramic decorating paint. The second plate for all capacitors is formed by a substantially continuous silvering of the reverse side of the high dielectric card. On this, the ground side, windows are provided

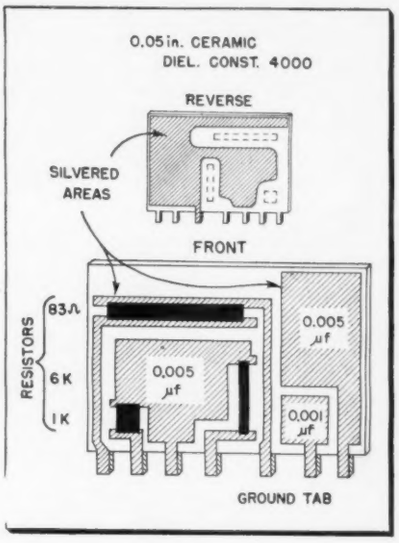

Fig. 8: RC card silk screened on dielectric

in the metallization opposite resistor areas on the front to reduce what might be a prohibitive stray capacitance. The pattern on the ground side is non-critical and is, therefore, produced by a permanent spray painting mask of simple design rather than by a second silk screen printing. Curing of the metallizing paint is feasible by batch firing in a muffle or in a continuous ceramic decorating lehr.

The three resistors on the card are produced by silk screening printing of a resin-graphite-lampblack mixture. Curing and protective coating as well as the composition of the mixture are closely controlled in processing to give resistors of acceptable commercial stability. The screening is done by an all-metal screening fixture of improved design in which the motion, angle, pressure and speed of the squeegee are controlled with precision adjustments. Attempt is thus made to remove all variables in the process which might

(*Continued on page* 116)

Ever try to price-tag precision?..

Absolute precision in a vital instrument—what's it worth?

> . . . to the bomber pilot trusting to Kollsman, instruments checked to one-ten-thousandth of an inch for accuracy.
>
> . . . to the ship's captain, banking all on the precision of his Kollsman sextant.

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Today—to maintain a free, strong America—Kollsman is devising, developing and manufacturing instruments of utmost precision, dependability and quality in the fields of:

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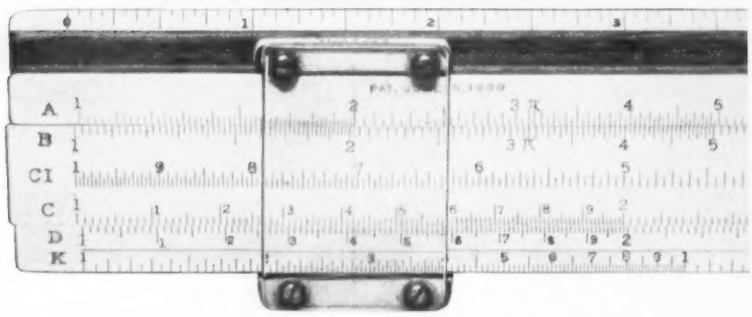

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THE PERFECTLY ROUND "NO-RUB" VOICE COIL (an Exclusive feature) is manufactured by keeping each coil on a separate hardened steel sleeve during winding and all other pre-assembly operations. Each coil is thus perfectly round when installed in the speaker. There are no egg-shaped coils to cause "rubs."

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Voice coils are multiple wound by automatic machine.
Metal stampings are completely designed and manufactured in the Engineering, Tool, Die and Punch Press Dept's.
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SPEAKERS CAN BE SUPPLIED WITH:—
Round or square frame.
.68 oz., 1 oz., 1.47 oz. or other standard Alnico P.M. sizes.
Plugs, Transformers and/or brackets to your specifications.

Other speaker sizes available with these same features are:—
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result from manual operation. After screening, the resistors are cured, insulated, and again baked.

The resistors on the card illustrated are simultaneously printed from the same mixture, and three values being determined by variation of the length-width ratio only. This is sometimes referred to as the "aspect ratio." The 1 K agc resistor has a square aspect which shows that the mix used basically produces carbonaceous films having an area resistivity of 1,000 ohms per square. Lengthening the resistive area so that the aspect ratio is 6:1 gives the 6 K input resistor; and making a very wide but short area enables the production of the 83 ohm cathode resistor, which has an aspect ratio of about 1:12. The total range of resistor value on this card, from 83 to 6,000 ohms, is thus a little over 72 times. This approaches the practical limit of variation in resistors which may be printed on the card from one mixture. Consideration must also be given in the design of printed resistors to see that there is a total area adequate to dissipate produced heat; a conservative standard is 1 watt/sq. in.

Resistor Functioning Lengths

It may be noted in the layout of the RC plate above that the functioning lengths of the resistors are set by the spacing of the contacts formed by the conductor pattern, while the widths are set by the pattern in the resistor stencil. This presents an additional problem of printing metallization and resistor mix in registration. Absolute registration between the two superimposed patterns is not of great interest but control of the de facto registration of successively printed samples is necessary to keep resistor variation within tolerance limits. This is accomplished by two register pins on the work holder of the screening fixture plus vacuum clamping which holds the work against these pins. Screen stencils for both capacitor and resistor areas are made on conventional bichromate sensitized film which adheres to the screen after contact exposure and washing out. Preparation of masters by drawing and photo reduction is identical to the procedure used for the etched copper laminate section.

Performance

The performance of unitized stages made up of the combined etched and silk screened components was checked by measuring overall response and i-f response in

(*Continued on page* 118)

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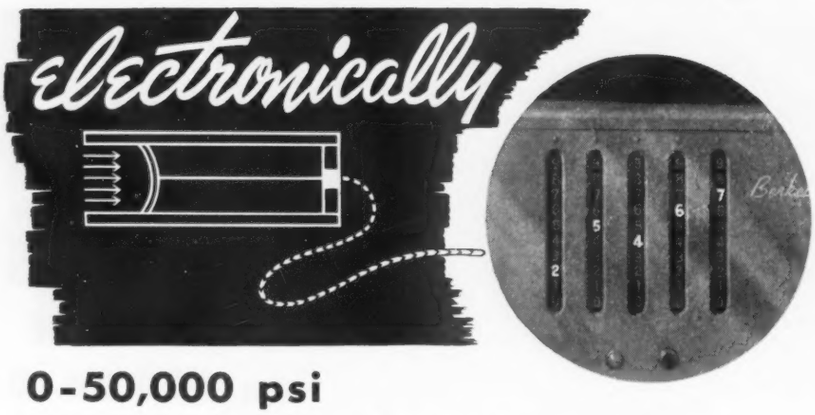
Pressure Measurement-



0-50,000 psi
WITH ACCURACIES TO .01%

METHOD: Direct reading digital indication of pressure variation is obtained by using the Berkeley EPUT (Events-Per-Unit-Time) Meter in conjunction with a pressure sensitive frequency generator. The sensing element emits a frequency which varies with pressure. This frequency is transmitted to the EPUT Meter and read directly on an illuminated front panel. The EPUT will count for a precise 1 second period and then read out for 1 second, thus providing independent samplings during alternate 1 second intervals.

ADVANTAGES: Minute variations of fluid pressures may thus be detected with accuracies to .01%. Remote indication can be obtained by telemetering over any desired range, or by cable transmission up to distances of 15,000 feet.

The sensing element is small in size (approx. 1" x 1" x 3") and extremely rugged in construction to permit mounting under practically any field or laboratory condition. This system then provides extreme utility, maximum safety factors, speed, accuracy, and simplicity of operation.

EQUIPMENT: A number of pressure sensing elements are available to accommodate various ranges of pressure from 0 to 50,000 psi. Several different models of the EPUT Meter may be used, depending upon the desired pressure range and the degree of accuracy required. Modifications of this equipment are available to provide extended time base for even greater accuracy and extended range, special mounting, explosion-proof housing, and other special facilities.

SPECIFICATIONS

	MODEL 554	MODEL 556
RANGE	20-100,000 cps	20-100,000 cps.
ACCURACY	± 1 cycle	Line voltage stability (approx. 0.1%)
TIME BASE	1 second	1 second
SHORT TERM STABILITY	Standard crystal—1 part in 10^5 Oven crystal—1 part in 10^6	Line voltage stability
POWER REQUIREMENTS	105v.-130v., 60c., 175w.	105v.-130v., 60c., 125w.
INPUT (any wave form)	0.2-50 volts rms (pos.)	0.2-50 volts, rms (pos.)
DISPLAY	Direct reading digital—variable 1-5 seconds	
DIMENSIONS	20¾" x 10½" x 15"	16⅝" x 10¼" x 12⅞"
PANEL	Standard rack 19" x 8¾"	15⅜" x 8¾"
PRICE	$775	$560

This is one of many broad applications wherein Berkeley instruments can provide direct reading digital presentation of information at extremely high orders of accuracy.

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a Sylvania Model #1-387 receiver, with substitution of printed for standard stages. The performance of the second video i-f module is represented by test results shown in Fig. 9. The solid curves are for a circuit containing the printed stage, and the broken curves for a set with all standard components. Measurement of i-f response was made by injection of signal at the mixer plate in the tuner, and the point-by-point plot of dc potential produced at the 2nd video detector. Overall response was checked by a 30% modulated signal fed into the tuner on Channel 4 setting and the output of the second video detector read by VTVM.

The performance of the printed stage in terms of response is equal to or better than the standard assembly. The skirts of both responses are down on the sound side and the bandwidths through the printed stage are adequate at the —3 db level. The difference at the top of the curves is of little significance except that it indicates that the

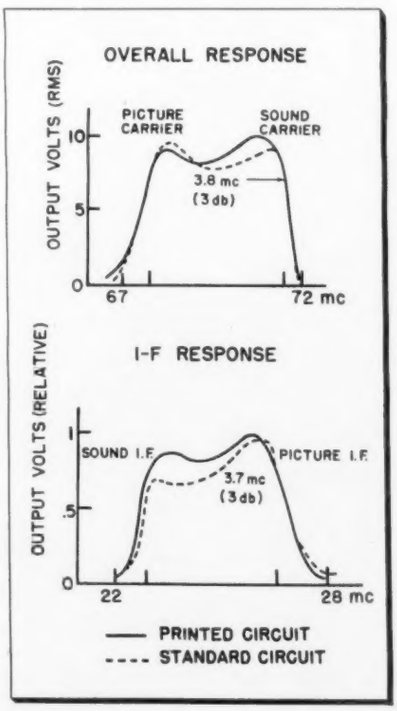

Fig. 9: Comparison of response characteristics of printed and standard 25 mc i-f circuits

alignment of the staggered circuits could be slightly improved. During development of the RC plates some difficulty was encountered by signal being bypassed by stray capacitances about the 6K input resistor. This situation was corrected by redesign of the layout of the silvered

(*Continued on page* 120)

494 feet above Philadelphia's busiest streets

Most city building codes are easily complied with, but nature's caprices are unpredictable. So, when both the building's owners and WPEN's engineers laid plans for a new AM-FM station atop their new mid-town building they called on Blaw-Knox to design, fabricate and erect a *safe* antenna tower. Their choice was based on the fact that Blaw-Knox has an unequaled record for successful tower installations in congested areas. WPEN's structure is designed to carry the additional load of TV bays if and when required.

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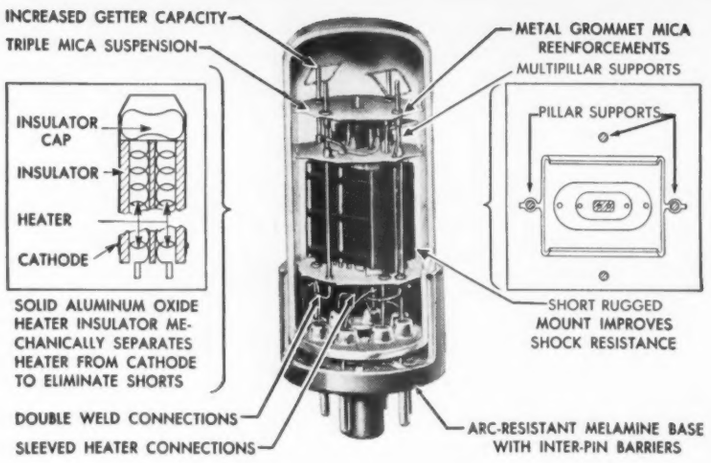

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Heater voltage—(A-C or D-C)	6.3 volts
Heater current	0.6 amps
Plate voltage—(max.)	300 volts
Screen voltage—(max.)	275 volts
Plate dissipation—(max.)	10 watts
Screen dissipation—(max.)	2 watts
Max. heater-cathode voltage	300 volts
Max. grid resistance	0.1 megohms
Warm-up time	45 sec.

(Plate and heater voltage may be applied simultaneously)

TYPICAL OPERATION

Single-Tube, Class A_1 Amplifier

Plate voltage	250 volts
Screen voltage	250 volts
Grid voltage	−12.5 volts
Peak A-F grid voltage	12.5 volts
Zero signal plate current	45 ma
Max. signal plate current	47 ma
Zero signal screen current	4.5 ma
Max. signal screen current	7.0 ma
Plate resistance	45,000 ohms
Transconductance	4,000 μmhos
Load resistance	5,000 ohms
Total harmonic distortion	8%
Max. signal power output	4.0 watts

PHYSICAL CHARACTERISTICS

Base	Intermediate shell octal 8-pin
Bulb	T-9
Max. overall length	3¼ in.
Max. seated height	2⅝ in.

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ground area on the reverse side as well as by shortening the printed connections to this resistor.

The combination of etched and silk-screened portions of the assembly into a complete module is shown in Fig. 6.

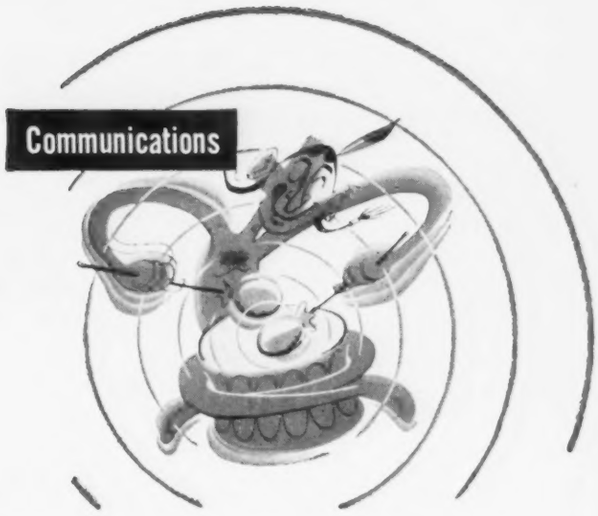
Assembling of all parts including the tube clips and connections to the coil centers is done by dipping in solder. The coils are protected during dipping by an adhesive paper mask.

The RC card is provided with legs which fit into punched holes in the etched plate, thus dispensing with wire leads. All crossovers have been eliminated from the layout except the necessary connections to the coil centers. For illustration purposes the etched plate is shown reversed with respect to the other parts, the RC card, tube and coil connections going above deck with all protrusions on the etched lower side for convenience in soldering. The brass tuning slug (not shown in Fig. 6) is inserted in the threaded hole in the bifilar i-f transformer. Tuning may be done with the head portion on either upper or lower side of the etched deck.

As a module of construction, the manner of connection to the next stage is of vital importance. A butt joint of the etched plates is affected with a punched dovetail between sections which is supplemented by a single screw and a pronged nut plate fastened through the ground bus. This arrangement holds two adjoining plates quite rigidly in all dimensions so that the abutting conductors may be soldered directly together without wire. This may be done in the same dip-soldering, during which the RC card is attached, so that at least two modules may be assembled and joined simultaneously. While this joint has proven satisfactory to normal handling it is anticipated that improvement may be made by interleaving or dovetailing conductor ends.

Extension of the principles embodied in this i-f stage to the overall unitizing of a receiver is illustrated in Fig. 7. Here, three of the interlocked etched panels, which replace the conventional steel deck, are shown in place in a pair of aluminum channel strips. Such channels are used as a rack into which unit assemblies may be inserted vertically as well as in both planar dimensions.

It is believed that such a module represents a considerable saving in critical materials as well as offering a method for more close integration of printed components and methods into receiver manufacture.



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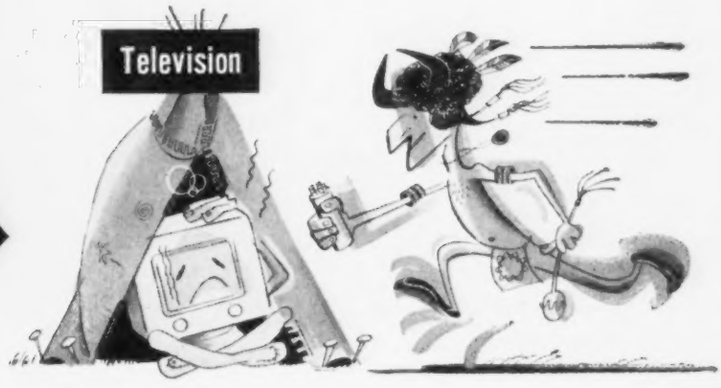

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PERSONAL

I. S. Coggeshall, past-president, IRE, who has been general traffic manager of Western Union Telegraph Co., has been appointed director of planning of international communications. A veteran traffic official, he was assistant to Western Union's traffic vice president for many years before transferring to international telegraph work. He has served as one of several communications liaison officers to the Navy Department, performing outstanding service for the Navy.

Freeman A. Spindell, chief engineer of Browning Laboratories, Inc., Winchester, Mass., has been elected to the office of vice-president. In addition to his new duties, Mr. Spindell will retain his responsibilities as chief engineer.

Dr. Alan Hazeltine, has been elected president of Alexander C. Humphreys Foundation. The foundation was organized a year ago to honor the memory of Dr. Humphreys, second president of Stevens Institute of Technology.

R. T. Capodanna has been elected vice-president in charge of engineering of Emerson Radio & Phonograph Corp. He has been director of engineering at Emerson since October, 1949.

Carl W. Concelman, formerly chief engineer at Industrial Products Co., Danbury, Conn., has been named manager of the Electronics Division, Mendelsohn Speedgun Co., Inc., of Bloomfield, N. J.

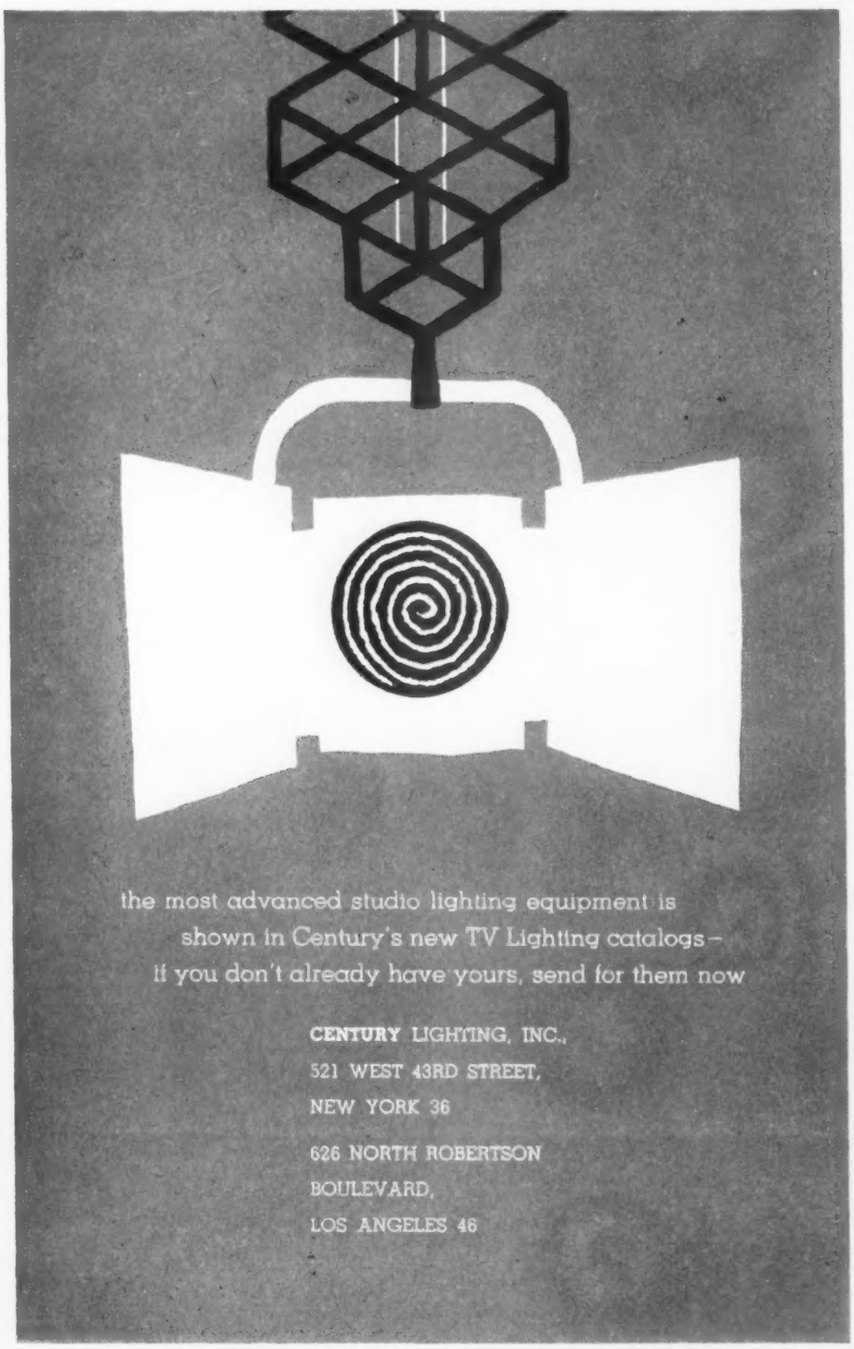
Frank W. Godsey has been named manager of four operating divisions of the Westinghouse Electric Co.: X-Ray and Electronics Div.; Air Arm Div.; and Special Products Development Div. Walter Evans, Westinghouse vice president, has relinquished his duties with these divisions in order to devote all of his time to the management of Westinghouse radio and television interests.

Welcome W. Bender has been appointed chief electronics engineer at The Glenn L. Martin Co., according to an announcement by William B. Bergen, vice president-chief engineer. Mr. Bender supplants John M. Pearce, resigned. The new chief of electronics engineering activities joined the Martin Company in 1939, shortly after receiving his master's degree at the Massachusetts Institute of Technology.

Edmund G. Shower will head the National Union Radio Corporation's new transistor division to be engaged in the manufacture of germanium and silicon diodes and transistors of both the point-contact and junction types. During his affiliation with the Bell Telephone Laboratories, he set up the company's initial transistor production line. On leave of absence from Bell Telephone Laboratories from 1943 to 1946, he served in the Navy. As a member of Bushps, he had charge of coordination of electron-tube design for the Naval Establishment with the Army, Air Force, Marine and Allied Agencies.

A. V. Loughren, vice-president of the Hazeltine Electronics Corp., has been appointed a vice-chairman of the National Television System Committee to replace Donald G. Fink who has resigned as a vice chairman.

James F. Cosgrove is announced as sales manager by Product Development Co., Inc., Kearny, N. J., for PRODELIN broadband coaxial cables and high gain transmitting antennas, featuring "Job Packaged" microwave installations.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RG-9A/U	RG-20/U	RG-54A/U	RG-74/U
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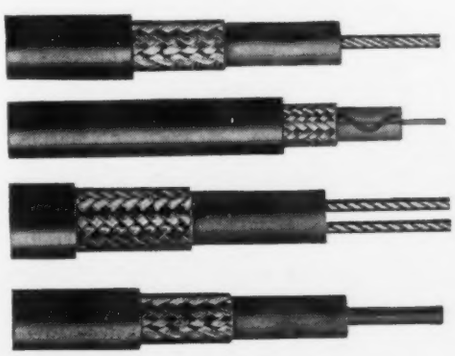

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POWER WAVEFORMS

(*Continued from page* 61)

electronic equipment, particularly radar, by theoretical means. An analysis showed, however, that this method led to too many mathematical difficulties, involving the use of Laplace transforms, for example. Equivalent circuits could not be used because assumptions would have to be made which would render the method useless so far as the effect of harmonics is concerned.

Experimental means, therefore, appeared to offer the most promising method of determining adequate wave form specification. A power source was needed in which the generator wave form could be controlled; that is, where all harmonics could be controlled both in amplitude and phase angle. As an approximation, a power source was used which consisted of two generators and provided the fundamental and third harmonic of 400 and 1200 c.p.s., respectively. They were both driven from a single drive-stand through a specially designed gear box which maintained proper phase relations between the wave components. The two generators were connected in parallel through filters which prevented them from short circuiting each other and helped to remove unwanted harmonics. These filters were designed to supply power to a 12-ohm load.

Using this power supply, electrical equipment could be operated under various wave forms by changing the magnitude and phase relation of the third harmonic. If any conditions for unsatisfactory operation could be found, then the wave form of the load voltage could be analyzed to determine what factors are responsible and to find what method of specification would eliminate the difficulty. A standard airborne radar was operated from this power supply with various wave forms containing third harmonic amplitudes of approximately 10, 15 and 20%. The phase relation between the fundamental and third harmonic was varied at 10° intervals through 360°. The rms value of the load voltage was held constant at 115 volts. The wave forms as seen on an oscillograph were recorded on 35 mm film and voltages existing in various parts of the radar including both regulated and unregulated power supplies were recorded.

There was no sign of malfunctioning of the radar throughout the test. Regulated voltages remained within 0.5% of their average values. The outermost range markers did not vary more than 1/32 in. Two voltage wave forms representing the flattest and most peaked wave were analyzed for harmonic content, crest factor, form factor and deviation factor. It was noted that the peaked wave contained noticeable fifth, seventh and eleventh harmonics which were not present when a resistive load was substituted for the radar. It was also noted that the radar load current contained many harmonics even for a sine wave voltage input.

In these tests, the radar was subjected to wave forms in which the crest factor exceeds the maximum tolerances prescribed in the generator specifications MIL-G-6099 and also the general specifications for electronics equipment 16E5(Aer). The third harmonic exceeded the maximum amount allowed in the generator specifications by up to four times; yet this radar operated without any difficulty.

It was necessary to readjust the magnetron current as the wave varied; however, this was to be expected and a rheostat was made easily accessible for this purpose.

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"Procurement Guide" as 21 x 30-in. Wall Chart

For the convenience of readers who would like to mount as a wall-chart the complete "Military Radio-Electronic Procurement Guide" which forms Section 2 of this issue, the publishers of TELE-TECH have arranged to reprint a limited number with all names and features on one side of a sheet 21 by 30 inches—thus showing at a single glance all details of Navy, Signal Corps and Air Force Electronic Procurement.

The price of this 21 by 30-in. wall-chart reprint is $1.00. Orders should be addressed to TELE-TECH, 480 Lexington Ave., New York 17, N. Y.

Television Checks Airport Weather

With the co-operation of DuMont equipment, the U. S. Weather Bureau is conducting daily tests at the Washington, D. C., National Airport, to determine how television can increase air safety by checking up on the variations in visibility over the field of a large airport.

The Weather Bureau is of the opinion that, in some cases, a pilot in the glide-path coming in for a landing may get a different view of runway visibility conditions from those reported from the normal observation point atop the administration building. But with runways over 5,000 feet long, even the observers about 2,000 feet away cannot see the whole stretch of runway in fog or low-hanging "soup." So a TV camera is stationed at the take-off point where it can "cover" every landing. As the camera operates, meteorologists see the televised image simultaneously on a monitor TV screen in the weather observatory. The TV camera crew can talk back and forth to the observatory over a microwave relay system.

MICROWAVES AT SEA

After a shakedown cruise in the Caribbean Sea, the Voice of America's sea-going broadcasting station Courier (page 41, April 1952 TELE-TECH) has sailed for an undisclosed destination to perform final tests and initiate transmissions to Soviet dominated areas. Shown above are the parabolic antennas for point-to-point relay from the 960 MC microwave system manufactured by the Link Radio Corp., New York, N.Y.

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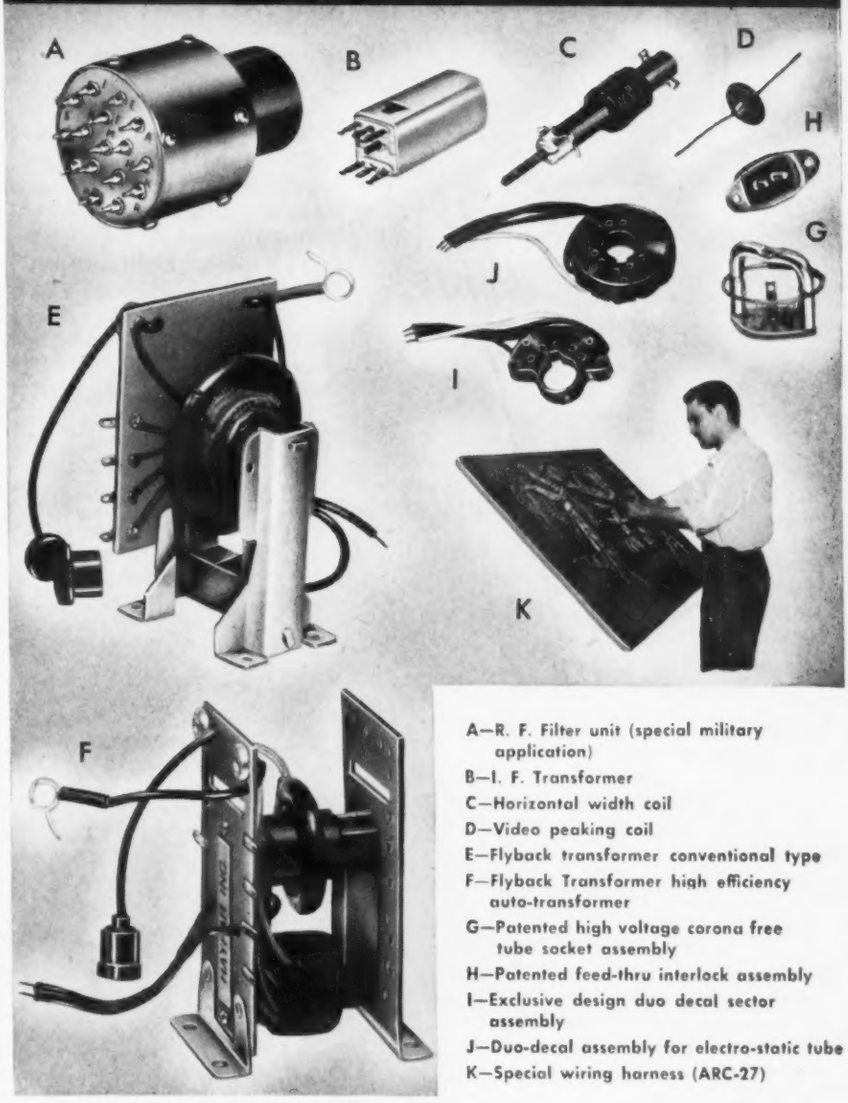

A—R. F. Filter unit (special military application)
B—I. F. Transformer
C—Horizontal width coil
D—Video peaking coil
E—Flyback transformer conventional type
F—Flyback Transformer high efficiency auto-transformer
G—Patented high voltage corona free tube socket assembly
H—Patented feed-thru interlock assembly
I—Exclusive design duo decal sector assembly
J—Duo-decal assembly for electro-static tube
K—Special wiring harness (ARC-27)

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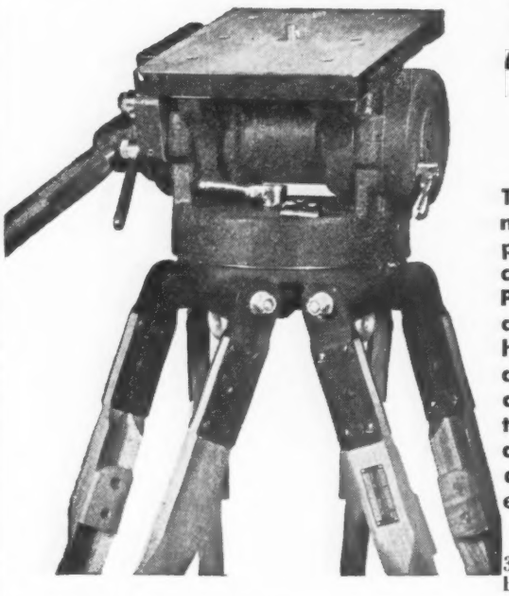

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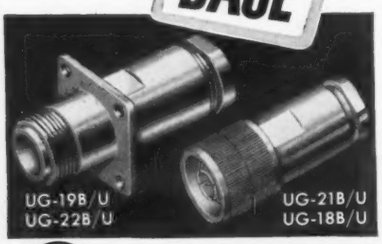

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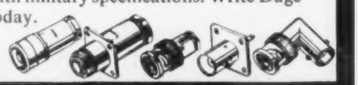

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67 North Second Street • Beech Grove, Indiana

Lightning Protection

(*Continued from page* 60)

ductor and the coaxial line, copper wire as small as No. 10 gauge has been used successfully for paralleling purposes. In general, the surge current divides about equally between the line and the parallel conductor and crushing is unlikely to occur except with unusually heavy surge currents.

With the smaller size lines or when the distance between the tower and the station is relatively long, it may be desirable to run the line in metallic conduit. At the tower end, the conduit and the coaxial outer conductor should be commonly bonded to the tower structure and in the building the conduit and coaxial outer should be connected to the station ground bus. The conduit, in addition to giving mechanical support, provides additional conductivity in parallel with the coaxial line, materially reducing the possibility of crushing. However, there have been field reports of lines being crushed by water freezing in such conduit runs so precautions should be taken to prevent the accumulation of water in them.

Land Communication Facilities

Remotely controlled fixed stations are common in a mobile system and consequently the land communication facilities are a vital link in the service. These stations are frequently in isolated locations where the antenna and connecting facilities are highly exposed to lightning. When the communication circuits are brought in by open wire, the protection problem is somewhat less than when small size cable is used. Although open wire will withstand relatively high lightning potentials, protection must be provided to equalize potentials where such circuits enter the station or connect with cable. At the station, all conductors should be connected to the station ground through discharge gaps. When open wire connects with cable, it is well at that point to provide a discharge gap between the sheath and each conductor in the cable. In addition to the gaps, grounding of the sheath at the junction will increase the protection and is particularly desirable in the case of small diameter cables having high sheath resistance.

An open wire line on jointly-used poles with a multi-grounded neutral power line having an operating voltage above 2900 v. rms to ground should be provided with gaps having

(*Continued on page* 128)

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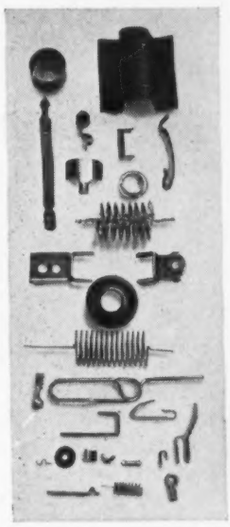

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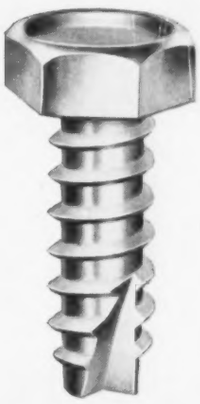

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a breakdown of about 3000 v. rms (.030 in. gap) connected between each open wire conductor and the multi-grounded neutral at intervals of about ½ mi. In the case of unigrounded and delta systems, since a low resistance neutral is not available for grounding purposes, it becomes necessary to construct protector grounds of sufficiently low resistance so that the voltage drops across these grounds during a power contact will not exceed about 3000 v. rms. However, the cost of constructing these grounds, which may be

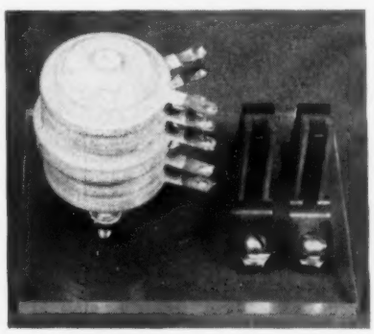

Fig. 6: Two-section varistor assembly and two carbon block discharge gaps provide for low voltage circuits

quite high, is a factor in considering the use of this type of protection. These gaps serve two purposes: first, they limit the voltage across telephone protectors located at other points; and second, they assist in the rapid de-energization of the power line by providing a low resistance path to ground for faulty current.

The protection of small size cable presents a greater problem as it is vulnerable to lightning damage from a rise-in-potential of the radio station ground and also from strokes directly to the cable and associated plant. Current from direct strokes to the antenna will divide between the station ground, the power line and the telephone line in inverse proportion to their surge impedances. As shown in Fig. 3, current entering the station ground will produce a potential with respect to a remote ground such as the protector ground at a subscriber station, and this difference in potential may cause pair to pair trouble. Furthermore, current in the sheath resulting from a heavy stroke to the antenna may cause dielectric failure between the core conductors and the sheath.

It is necessary, therefore, to limit these potentials with discharge gaps connected between the sheath and all cable conductors entering the station. The sheath should be con-

(*Continued on page* 130)

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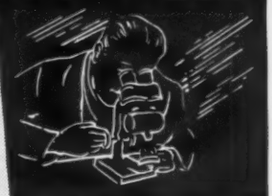

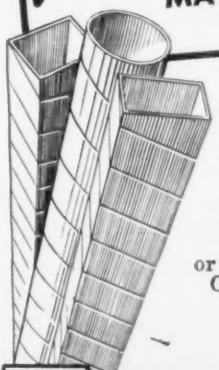

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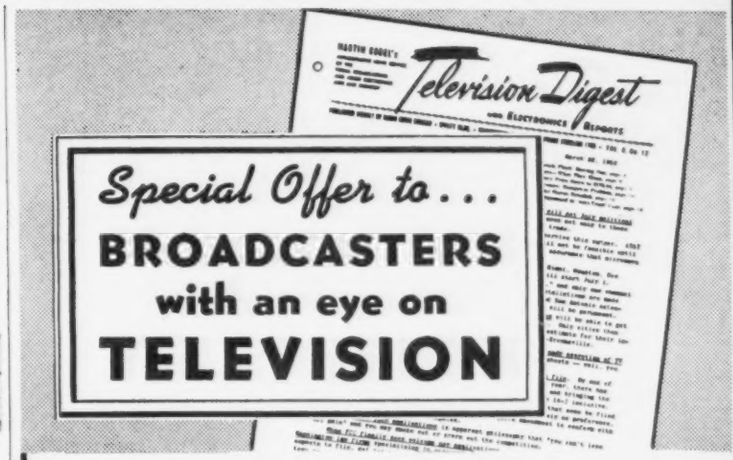

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Output frequency:	20 cps ± 1.5 cps
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nected to the station ground as discussed previously in the section on common grounding. This will equalize potentials at the station, but with long runs of small diameter cable, it is often necessary to provide equalization at intermediate points. It has been found in practice that adequate protection will generally be provided by applying discharge gaps to all cable conductors at intervals of about ¼ mi. between the station and a point where the surge current in the sheath has been substantially reduced by shunt paths to ground. Some latitude is permissible in the selection of these equalization points and preference should be given to locations where favorable grounding conditions exist. When a cable is supported on poles with a multi-grounded neutral power system, bonding of the sheath to the common neutral is in most cases more desirable than a made ground. Such interconnection provides additional grounding paths for lightning currents in either system. In situations where the exposure is particularly great and the earth resistivity is high, it may be necessary to use higher dielectric cable or parallel the sheath with wires installed aerially or buried under the cable to reduce the sheath current and thereby the resultant core-sheath voltage.

Power Line Surges

The equipment and tower lighting in stations served by overhead power lines are vulnerable to damage from lightning surges originating on the power system. Experience indicates that in suburban and rural areas, the probability of trouble from this source is sufficient to justify the application of special protection on the service conductors and the branch circuits. The installation of secondary circuit power arresters (1.6-1.8 kv. operating potential) installed on the service conductors either at the weather head or service cabinet have provided satisfactory protection for the miscellaneous power and lighting equipment customarily operated on branch circuits.

With an underground power service in either iron conduit or employing steel clad cable, it is often desirable to install a distribution type arrester (about 3.0 kv. breakdown) on the secondary conductors at the power pole. The ground lead of the arrester should be connected to the conduit or cable sheath and at the station the conduit or sheath should be bonded to the common building ground. This arrangement utilizes the impedance introduced by the metallic covering over the serv-

ice conductors to reduce the duty on the station arresters and materially raise the level of protection.

Secondary circuit arresters operating at 1800 peak v. will not adequately protect radio equipment. Therefore, a low voltage protector operating at 600-800 peak v. has been used extensively in the Bell System on 120 v. ac branch circuits to protect low rated electronic equipment. This protector consists of a .600 in. carbon block discharge gap in series with a silicon carbide varistor.

Fig. 6 shows a two-section varistor assembly and two carbon block discharge gaps which will provide low voltage protection for two 120 v. branch circuits. These components may be arranged in various ways to facilitate mounting in the radio cabinet. The varistor prevents 60 cycle power-follow and the small resistance introduced by it materially extends the life of the gap. These low voltage branch circuit protectors should be installed in the radio equipment cabinet on the line side of the fuses.

In this location the device will not only protect the equipment from dielectric breakdown, but will reduce the possibility of equipment fuse operation on surges.

It is also recommended that time delay type fuses or circuit breakers be substituted for the branch circuit power fuses on circuits equipped with the low voltage varistor protector. Tests indicate that a higher level of protection will be secured if there are at least several feet of iron conduit between the service entrance and the location of the low voltage protector. Considerable benefit can be derived from the impedance introduced from such conduit as shown in Fig. 5.

The power protection just discussed is intended primarily for the protection of the station equipment. At locations where no provision is made for standby power service, it is desirable to consider the adequacy of the protection on the power line itself. The multi-grounded neutral power circuit usually provides a low resistance path to earth on the neutral and in combination with the station ground provides a grounding system that can be of considerable mutual benefit. Power systems, however, which do not provide some path for surge current between primary and secondary neutrals are more likely to be damaged by lightning. As a result of a stroke to either the power line or the station, a potential will appear between the primary and secondary windings of the

(*Continued on page* 132)

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FREQUENCY RANGE: 20 mc. to 260 mc.

RANGE OF Q MEASUREMENT:

Q indicating voltmeter	50 to 400
Low Q scale	10 to 100
Multiply Q scale	0.5 to 3.0
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Total Q indicating range	5 to 1200

PERFORMANCE CHARACTERISTICS OF INTERNAL RESONATING CAPACITANCE: Range — 7 mmfd. to 100 mmfd. (direct reading).

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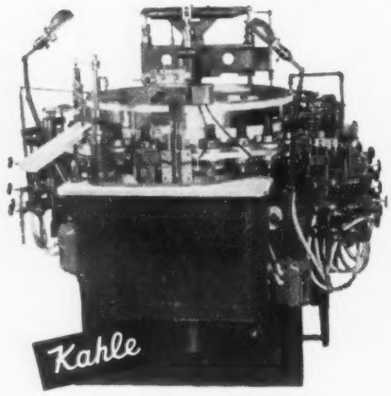

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distribution transformer serving the station that may damage the windings and interrupt service.

Fig. 5 shows a particular power connection at a radio station where the distribution transformer was damaged by lightning. It may be noted that interchange of surge current between the station ground and power primary neutral grounds would create arcing in the transformer. Interconnection between primary and secondary neutrals or between the primary arrestor ground and the secondary neutral is desirable. In the case shown in Fig. 5, interconnection may be by means of a discharge gap between the primary arrestor ground and the secondary neutral as shown in the figure.

The problem of protecting the fixed stations of a mobile radio system from service interruptions due to lightning is not confined to the station equipment and the antenna system, but consideration must also be given to the connecting power and land communication facilities. The protection methods discussed have been successfully employed in Bell System radio installations and many of the arrangements will also provide satisfactory protection for other types of equipment.

Associated with the technical solution of a protection problem is the matter of cost. The amount of protection applied should be determined through a consideration of the probable savings in plant damage expense and the value placed upon continuity of service.

From CP to TV

(*Continued from page 41*)

with the FCC—apart from attorneys' fees if employed. The average engineer should be capable of completing the engineering section Form 301 in uncomplicated cases, but it is generally advisable for applicants to employ an attorney familiar with FCC procedure for the completion of the balance of the form. It is also a good idea to have the engineering checked by a consulting engineer if the engineer has not had previous experience in dealing with the FCC. If there are any errors in the form, or if it does not comply with the FCC rules, it will be returned. This may result in a delay of three or four weeks before the application receives a file number and is accepted for filing.

After the construction permit has been issued, a period of six months is allowed for completion of construction, which must commence

within two months of being authorized, allowing a total of eight months. If construction cannot be completed by the end of this time FCC Form 701 *application* for extension of time to construct must be filed at least 30 days before the original CP is due to expire. This is a simple one-page form which merely requests the reasons why construction cannot be completed, which in many cases may be delayed in equipment delivery.

In the past, the FCC has been very benign towards laggards in construction. However, just before the imposition of the freeze at the beginning of 1948 a decided tightening up in its attitude was noticed. A number of potential telecasters lost their construction permits about this time due to slowness in getting started. However, it is probable that the FCC knowing the difficulties faced by potential telecasters in obtaining steel and copper, will be reasonable in granting justified extensions.

It is well to note that during the time of construction, if any major changes are proposed, a modification of construction permit on Form 301 must be obtained before proceeding with the new and different construction, sometimes requiring a time extension. However, applying for a modification may cause work to be held up until the original construction permit has expired. Although an applicant may be awaiting a modified CP he is still charged with the responsibility of obtaining extensions of his current CP until he receives permission to go ahead with the modification. In other words, after modified Form 301 has been filed it is sometimes necessary to file a Form 701 to keep the existing construction permit alive.

After construction has been completed the applicant is allowed to begin equipment tests provided the FCC and the local engineer in charge of the radio district are notified at least 48 hours in advance.

After satisfactory equipment tests are completed, program test permission may be requested at least 10 days before the date desired, and the local engineer in charge notified. Normally, the FCC requires that Form 302 application for license be filed at the same time that permission to go on program tests is requested. This application requires proof of performance, including measurement of the video signal transmitted. Therefore, it has been the FCC's practice in the past to permit a TV station to go on program test with a special temporary authorization (STA) pending application

(*Continued on page* 134)

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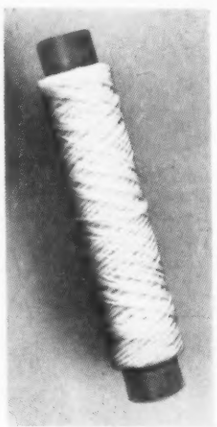

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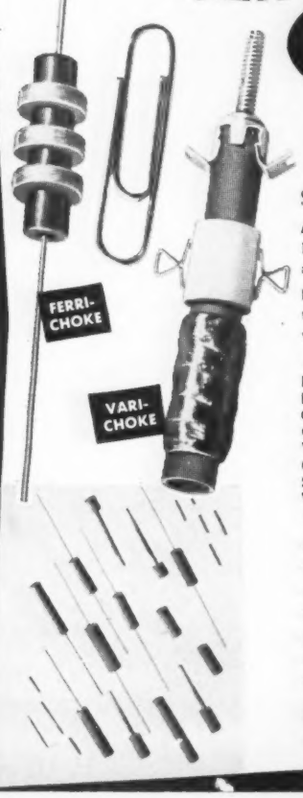

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ELECTRICAL COMPARISON between Grayburne and Conventional RF Chokes proves Grayburne superiority (both chokes valued at 2.5 mh, 125 ma).

GRAYBURNE	FERRI-CHOKE	CONVENTIONAL RF CHOKE
L	2.5 mh	2.5 mh
R	10.5 ohms	40.0 ohms
Cd	1.7 uuf	2.8 uuf
Q	110	45
Wire length	30.0 ft.*	96.0 ft.
Core	Ferrite	Isolantite
Size	1" long x ⅜" diam.	2½" long x ½" diam.
Wt.	4.5 grams	13.5 grams

***NOTE:** *COPPER SAVINGS OVER 200%*

Grayburne Vari-Chokes: variable over a wide range of inductance, in many cases as high as 10-1 ratio.

Grayburne Ferri-Chokes and Vari-Chokes can be supplied in the inductance, mounting and type of winding you specify.

Grayburne Ferrite Core Kits of 27 various-sized cores, fixed and variable, are available for your development and research purposes. Net. $2.25.

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for a license, or with part of the engineering data to be submitted later.

Assuming that the applicant has obtained a license to operate his station, he will then in all probability require remote pickup equipment, which is licensed only to broadcast licensees. Application, for this authorization is made on FCC Form 313, which is used to apply for a CP, license, renewal and modification. In these cases, where commercial remote transmitter and receiver are designed to work together, application for construction permit and license may be made simultaneously by submitting *two* Forms 313, one checked to indicate application for CP and the other checked for application for license.

Hearings

If it appears that the data submitted in support of the application does not comply with the FCC's Rules and Regulations and The Standards of Good Engineering Practice, or that the applicant is not qualified, or more than one applicant applies for the same facility, the FCC will institute a common hearing.

Generally, 30 days, at least, is allowed between the date of setting the hearing and the date on which the hearing is to be held. During this time it is often possible for an applicant to correct or satisfy the issues by amending his application—particularly if the hearing is based on engineering inconsistencies.

At the hearing all people involved in completing the original application form may be required to testify in support of their statements. An applicant's engineering representative must be capable of handling technical questions from the opposition's engineering counsel and attorneys. This involves a comprehensive knowledge of the Rules and Regulations and The Standards of Good Engineering Practice, as well as the technical data concerning the applicant's station. This is another good reason for employing an experienced consulting engineer.

Form 301 has been revised and only those forms dated 6-30-52 will be accepted. This means that all applications currently on file will have to be amended using the new form and supplying the additional information required.

A recently announced FCC instruction states that applicants answer all questions of Section IV of Form 301 and that the words "Except that TV applicants are to answer only paragraphs 9, 10, 11, 12" in instruction I be deleted.

Defense Procurement

(*Continued from page 37*)

North Carolina, Massachusetts, Pennsylvania, Maryland, Rhode Island, Illinois, Michigan (Detroit, Flint, Grand Rapids, etc.), all of the New York metropolitan area, Nassau and Westchester. (New Jersey is *not* a distressed area at this time.)

How are the three military services meeting this new policy?

SIGNAL CORPS. Manpower Policy No. 4 has brought about a drastic change in Signal Corps procurement practice. This agency has ordered complete reversal of its practice of negotiating the greater part of its procurements. Henceforth Signal Corps will process as many of its contracts as possible on a formal advertised basis—not subject to Manpower Policy No. 4.

NAVY. At this time of writing, the Navy is furthest advanced in implementation of the manpower policy. Small business representatives, who will have considerable to say in the operation of the new policy are themselves in operation. The intent of the new policy is being observed by Navy personnel and its effect is already being felt by manufacturers in the communications industry. It is applicable to all contracts over $5,000, by Navy directive.

AIR FORCE. With the Air Force scheduled to spend more than 50 per cent of the total sum to be expended by all military services for radio-radar - communication - electronic equipment, Air Force interpretation of Manpower Policy No. 4 will be of considerable importance to the communications industry. It is anticipated that the Department of Defense might apply its preferential policy to the aviation industry regardless of geographical location and employment conditions.

Small Business in Control

Small business representatives, operating under authority of the Small Defense Plants Administration are now in a position to control the direction of procurement awards within the scope of Manpower Policy No. 4. The SDPA has placed, or is in the process of placing, a small business representative in the office of every military procurement agency.

Although it appears that small business is in the saddle, it is definitely not in the money as evidenced by the dollar value of contracts issued to small business by military services.

(*Continued on page 136*)

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New military and commercial, also "hard to get", out of production and scarce items specified for your contracts.

Complete service and facilities for currently manufactured units and components for communications and electronic manufacturers.

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Let us quote on your requirements and demonstrate prompt delivery on large or small quantities of components parts or complete equipments.

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M-19	H-81/U
M-29	HS-16
53-BW	TS-14
F-1	HS-25
D-141914	HS-30/U
N-1	HS-33
TD-4	ANB-H-1
T-17	HA-1
T-26	HC-3
T-38	AN/URA/1
T-45	NT-49534
51092	CX-3/AR
H-12/GT	CX-67/GT
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H-23	CD-933-E
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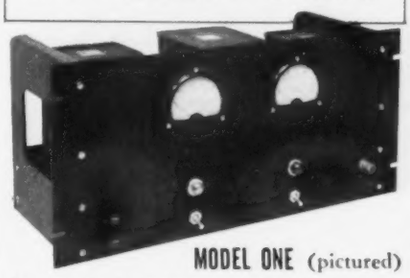
LABORATORY INSTRUMENT GRADE



MODEL ONE (pictured) is a 300 vdc, 0-300 ma supply, conservatively built for years of reliability, and featuring a specially stabilized high-performance electronic regulator.

★ Ripple and jitter: below 1/2 mv
★ Impedance level: below 1/10 ohm

All transformers and inductors are hermetic and have grain-oriented cores. Four 15 mfd oil capacitors are employed — one directly across the output for impulse stability.

Operates from 50-60 cycle, 115 volt line. Suitable either on bench or rack.

MODEL ONE, as above, FOB Factory . . $424

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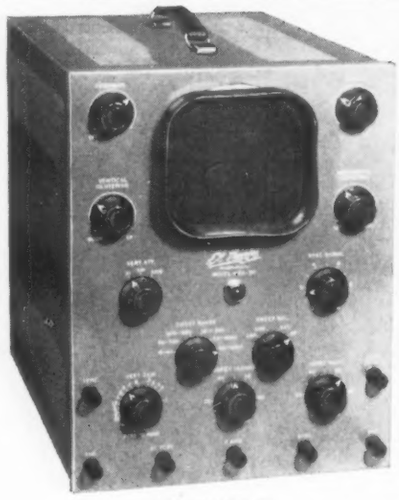

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AT A NEW . . . LOW PRICE!

This superior LABORATORY instrument possessing many outstanding features. A vertical amplifier of 5 mc band-width; a sweep oscillator variable to 150 kc in 6 ranges; full 4" vertical deflection without overload. Excellent reproduction of 1 MC square waves. 30 cycle square wave tilt less than 5%. Slotted bezel for insertion of graduated scale and light filter. Calibrated continuously variable vertical gain control. Never before could you obtain so many outstanding features in a laboratory precision scope at this low price. Write for Bulletin.

The Vertical Amplifier has a sensitivity of 20 millivolts RMS per inch of deflection, a frequency response (Sine Wave) of 20 cycles to 5 megacycles that is down only 3db at 5mc, a square wave response that is an excellent duplication of all square waves between 30 cycles and 1 megacycle with a maximum tilt of 5% for 30 cycle square wave, a maximum input potential of 1000 volts peak to peak, and an input attenuator of X1-X10-X100 positions, frequency compensated.

The Horizontal Amplifier has a sensitivity of 0.3 volts RMS per inch of deflection, and a frequency response (Sine Wave) flat to 300 kc.

The Recurrent Sweep Oscillator has a frequency range of 10 cycle to 150 kilocycles in 6 steps, with excellent linearity over entire range. Expanded horizontal deflection.

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$249.50* F.O.B. Factory *Price subject to change

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The Air Force has established a Small Purchases Section in the Material and Modification Sub-Division (see Procurement Guide with this issue) for the purpose of expediting off-the-shelf procurements of $10,000 or less. An Electronic Unit functions in this Section.

Small Business Reps

The Navy has small business representatives functioning with each of its Bureaus. They review all procurement actions to determine if small business can perform the contract. Within their authority, they are the key to where a contract goes. These small business representatives are identified on the new Procurement Guide.

Signal Corps has a smoothly functioning small business office attached to the Signal Corps Supply Agency in Philadelphia—also identified on the Procurement Guide.

Radio-TV Productivity Study is Available

Radio-TV factory performance and productivity of 16 manufacturing plants are analyzed in the Bureau of Labor Statistics report, "Radio and Television Manufacturing: Case Study Data on Productivity and Factory Performance," which may be obtained free from the Bureau's Regional Office.

Check up **CHECK OUT**

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108-132 Megacycles
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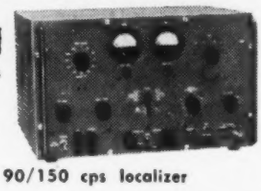

Signal source for bench or ramp testing of VHF airborne omnirange and localizer receivers. RF output for ramp checks, 1 volt into 52 ohms; for bench checks, 0-10,000 microvolts.

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News of MANUFACTURERS' REPS

Edward Ollick, president, Keystone Products Company, Union City, New Jersey, has announced the appointment of H. C. Stockfleth & Asso. as manufacturer's representatives for Keystone special purpose and Keystone custom made transformers. Stockfleth and Assoc. maintain offices at 78 Main Street, Madison, N. J. and in Philadelphia, Pa.

George E. Harris, head of the George E. Harris, and Company, Wichita, Kansas, has been appointed Sales Representative for the Halldorson Transformer Company, Chicago. Mr. Harris and his associate, John B. Pilkington, will call on distributors for the Halldorson Co., in Kansas, Missouri, Nebraska, and Iowa.

United Technical Laboratories, Morristown, N. J., has appointed three new sales representatives for *Klipzon* self-holding test probes, test prods and connectors. The G. G. Willison Co., Houston, Texas will cover Oklahoma, Arkansas, Louisiana and Texas; Bill Bartleson of Minneapolis, Minn. will cover North Dakota, South Dakota, Minnesota and northwestern Wisconsin; and Harris Pound of Montreal, Quebec will cover all of Canada except the Province of British Columbia.

M. F. Klicpera Co., representatives for electronic suppliers in the states of Texas, Oklahoma, Arkansas, Louisiana, and Mississippi, announces the completion of sales offices in Tulsa, Oklahoma City, and Dallas with home offices in Houston, Texas.

Max Heidenreich has announced that R. W. Amos had joined him as an associate in his manufacturers' agency, 5611 W. Hanover St., Dallas, Tex.

Junction Transistors Available from GPC

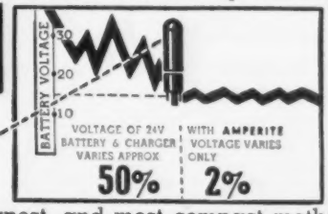
Germanium Products Corp. (subsidiary of Radio Development and Research Corp.), Jersey City, N.J., has announced that junction transistors are now available in commercial quantities through their exclusive distributor, Federated Semi-Conductor Co., 66 Dey St., New York, N.Y. Selling price of the plastic embedded Type RD2517 is $30, and 10 day delivery is expected. Operating characteristics of this n-p-n germanium crystal amplifier is described as follows: collector voltage supply, —45 v.; collector current, 400μa; emitter current, —175μa; emitter voltage, 1 to 3 v.; gain at 1 KC, 20 db; input impedance, 500 ohms; load resistance, 60 K; and frequency response within 0.5 db from 30 CPS to 20 KC.

AMPERITE

THERMOSTATIC METAL TYPE
Delay Relays
PROVIDE DELAYS RANGING FROM 1 TO 120-SECONDS

FEATURES: — Compensated for ambient temperature changes from —40° to 110° F . . . Hermetically sealed; not affected by altitude, moisture or other climate changes . . . Explosion-proof . . . Octal radio base . . . Compact, light, rugged, inexpensive . . . Circuits available: SPST Normally Open; SPST Normally Closed.
PROBLEM? Send for *"Special Problem Sheet"*

Regulators



Amperite REGULATORS are the simplest, lightest, cheapest, and most compact method of obtaining current or voltage regulation . . . For currents of .060 to 6 Amps. . . . Hermetically sealed; not affected by altitude, ambient temperature, humidity.
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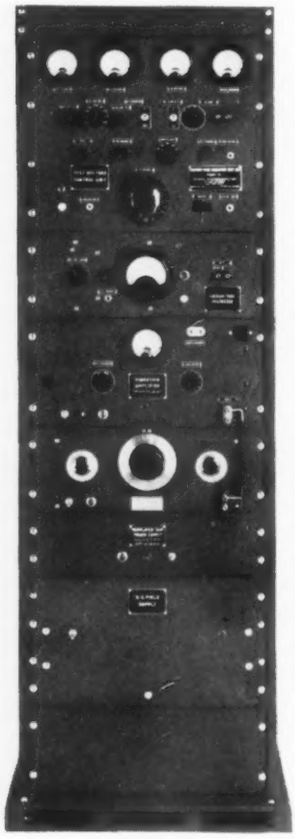
VACUUM TUBE VIBRATION TEST SET

Specifically designed for the testing of receiving tubes, including miniature and subminiature types, under static voltage conditions while subjecting the tube to vibrations of 10 to 1000 cycles per second. Noise output is measured directly by a Vacuum Tube Volt Meter having a range of .001 volts to 100 volts r.m.s.



MODEL TS-1

- Tube socket connections may be varied in accordance with the requirements of any particular tube type under test.
- Meters for direct, continuous readings of all operating voltages.
- Precision VTVM for use either as a separate voltage amplifier or for measurement of noise output voltage.
- Hi-Stability oscillator (frequency range; 10 cps to 20,000 cps) used to drive the vibrator or as a separate audio oscillator.
- Continuously variable power and frequency input to transducer for control of tube vibration.
- Vernier controlled, regulated power supplies.
- Sturdy steel construction, mounted on roller truck if desired — supplied in either grey or black ripple finish.

Individual requirements may be specified. Write, phone, or wire immediately for further information

General Electrosonics, Inc.

32 W. 22nd Street, New York 10, N. Y.

Telephone: ORegon 5-0085

Low-Temperature Capacitors

(*Continued from page 53*)

temperature performance is noted if the capacitors are operated continuously at +85°C at rated voltage for extended periods of time. However, for applications where the operating life does not exceed approximately 50 hours at +85°C, the low temperature characteristics are not seriously harmed.

As will be noted, these capacitors show very little change in impedance between −40 and +65°C. Since the room temperature impedance values are extremely low, the actual values of impedance at −55°C are quite low also, even though the curves indicate a 200-250% increase at −55°C. Since the actual measured values of capacity in practically all cases run over the rated values (as is normal with electrolytics in general) it is not uncommon for the capacity values of these capacitors to be within their room temperature capacity tolerance at −55°C.

Capacitors of this design have very low equivalent series resistance and power factor. Their 120 cycles series resistance limits are from one-third to one-fifth the limits set up for equivalent ratings of JAN C62.

One very important characteristic is the effect of idle shelf storage on the electrical characteristics of the electrolytic capacitor. The curves shown in Fig. 4 are typical of data which were taken on production made capacitors. Measurements were made, then the capacitors were allowed to stand idle with no voltage applied for a period of 3 years and 2 months. As can be seen, recovery to low values of DC leakage at 150 v. occurred quickly and indicate the same quality as newly made units when tested in final inspection. Measurements of capacity and equivalent series resistance before and after the storage period indicated only a small shift in capacity and a slight decrease in resistance.

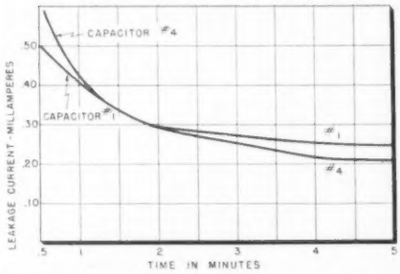


Fig. 4: Leakage current after 38 months of shelf storage. Capacitor ratings: 20 μf, 150 volts

The capacity and impedance curves shown in Fig. 2 and Fig. 3 are

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Hold Tubes in Sockets under all Vibration, Impact and Climatic Conditions

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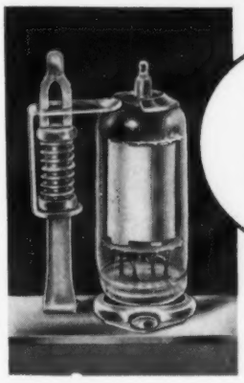

NEW CLAMP FOR MINIATURE TUBES

You can't shake, pull or rotate a tube out of place when it's secured by a Birtcher Tube Clamp. The tube is there to stay. Made of Stainless Steel, the Birtcher Tube Clamp is impervious to wear and weather.

BIRTCHER TUBE CLAMPS can be used in the most confined spaces of any compact electronic device. Added stray capacity is kept at a minimum. Weight of tube clamp is negligible.

Millions of Birtcher Tube Clamps are in use in all parts of the world. They're recommended for all types of tubes: glass or metal—chassis or sub-chassis mounted.

THERE'S A BIRTCHER TUBE CLAMP FOR EVERY STANDARD AND MINIATURE TUBE!

Write for samples, catalogue and price lists.

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typical of all voltage and capacity ratings of capacitors of this design. Double curves are used to indicate limits expected of these characteristics.

Reduced anode area and the resultant increase in the electrolyte resistance adversely affect the characistics the lower and the voltage rating. For this reason, the lowest voltage ratings are limited to 50 volts in the new designs; although in practice these units may be operated at any lower voltage without difficulty. Units having higher voltage ratings include those for working voltages of 150, 225, 300 and 450 volts.

Servomechanisms

(*Continued from page 63*)

damping. The amplitude ratio is 2.43 giving a ζ of 0.21. The results of applying the approximation are shown in Table IV.

Note that in this case there was a considerable error in the prediction of resonance. This was due to the low damping used on the system. It also emphasizes the need for accurate measurements where several component transfer functions are to be combined.

An examination of System "D" illustrates the effect of removing transmission lag in a fast flow control loop. The component frequency response is shown in Fig. 19.

The smaller phase lag shown in the open-loop frequency response diagram on Fig. 20 indicates a much faster recovery from transients.

In this case the dynamic behavior of the system, with high gain settings on the controller and under conditions of sudden changes in set point pressure, was influenced to a considerable degree by the non-linearities of the components within the control loop. It was found, however, that the linearity of the system could be improved by adjusting the controller settings for a slightly overdamped system response thereby making frequency response data applicable in defining the dynamic characteristics of the system. The closed-loop frequency response is shown in Figure 21.

Note that no amplitude peak occurred in the plot of the relation between amplitude ratio and frequency.

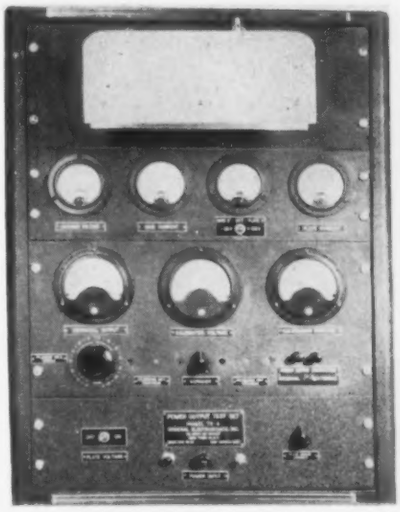
This illustrates a case where the simple methods of examining the frequency response in the region of resonance, used in the first three examples, break down. From the open-loop frequency response, however, some observations can be made

(*Continued on page 141*)

Available for the First Time

POWER OUTPUT TEST SET

FOR MEASUREMENT OF RF POWER



DIMENSIONS: 28"H x 21"W x 15"D
SHIPPING WT.: 75 LBS. (APPROX.)

Illustrated—MODEL TS-4

400 MC silver plated oscillator for 5703 type subminiature tube. Designed to meet all requirements of JAN 5703 specifications.

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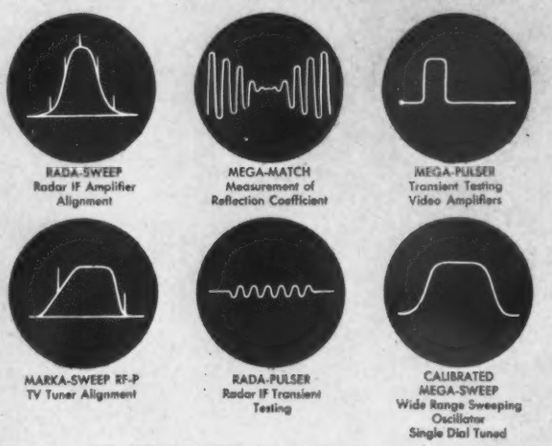

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Radar IF Amplifier Alignment

MEGA-MATCH
Measurement of Reflection Coefficient

MEGA-PULSER
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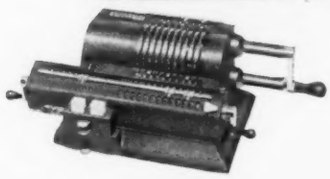

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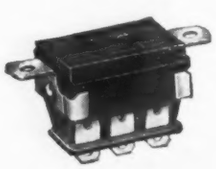

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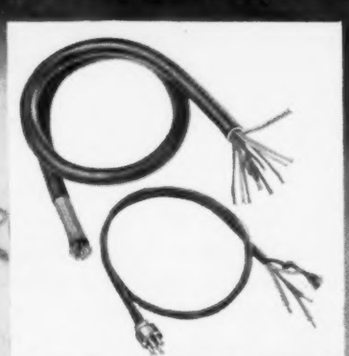

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as to the system performance. If the open-loop frequency response curves of Systems "C" and "D" are compared, a decrease of phase lag and attenuation for the same frequency range is noted in System "D." A decrease in phase lag and attenuation is indicative of faster recovery to the control point following an upset.

Conclusions

The four examples covered indicate that the servo analysis methods can be applied to process control problems to obtain useful and reasonably accurate predictions of performance. Obviously, for maximum utility of frequency response data, the information must be evaluated in the light of previous control, and process experience. It supplements but does not replace experience.

The development of this technique is in its early stages. An examination of the blocks to be analyzed shows that some of the blocks are under the jurisdiction of process designers and plant operators while others are the responsibility of the instrument manufacturers. The success of the program will be dependent upon the extent to which all three participate. Naturally, there will be limitations of the method.

(*Continued on page 143*)

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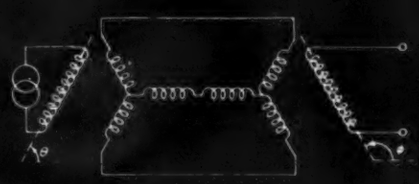

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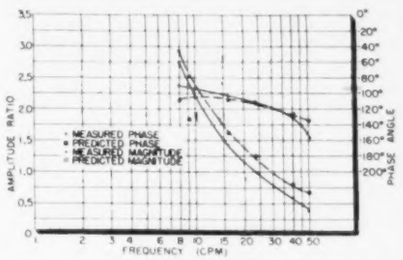

Fig. 20: Open loop frequency re:ponse-(D)

individual components of the system.

2. To establish the necessary response characteristics which an instrument or process being designed must have in order to make the complete system into which it is installed operate as desired.
3. To allow the designer to determine the source of undesirable effects and to minimize their effect, either by a change in process or instrumentation or by intelligent compromises.
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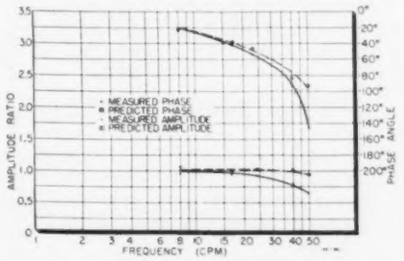

Fig. 21: Closed loop frequency response-(D)

transfer function. Naturally practical experience is of tremendous importance for this type of work.

7. Performance can be predicted,

(*Continued on page 144*)

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The authors wish to express their appreciation to E. C. Grogan for his assistance in assembling the test data.

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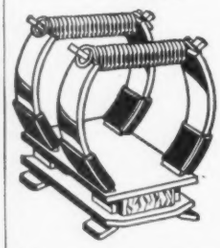

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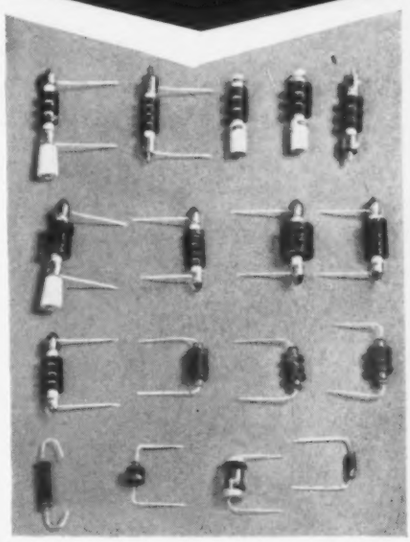

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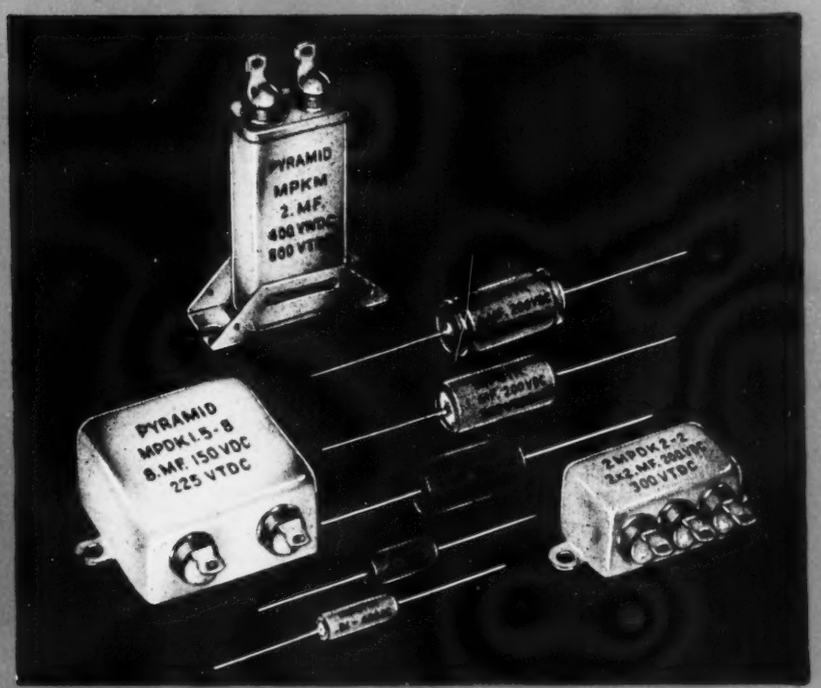

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Peak	5 max. amp
Average*	0.5 max. amp
Fault, for duration of 0.1 sec. max.	20 max. amp
GRID-NO. 2 CURRENT:	
Average*	0.05 max. amp
GRID-NO. 1 CURRENT:	
Average*	0.05 max. amp
PEAK HEATER-CATHODE VOLTAGE:	
Heater negative with respect to cathode	100 max. volts
Heater positive with respect to cathode	25 max. volts
AMBIENT TEMPERATURE RANGE	−75 to +90° C
Maximum Circuit Values:	
Grid-No. 1—Circuit Resistance	2 max. megohms

*Averaged over any interval of 30 seconds maximum.
#Absolute values

NOW—precise electronic control at lower cost with the new RCA-6012 gas thyratron

Expressly designed for industrial control applications, the new RCA-6012 gas tetrode features the ruggedness necessary to withstand rough industrial usage. It has the additional advantages of low cost and nationwide renewal distribution...both of importance to the end user.

For motor-control, electronic-inverter, and general relay service at power supply frequencies, the RCA-6012 is rated to withstand a maximum peak inverse anode voltage of 1300 volts, a maximum peak cathode current of 5 amperes, and a maximum average cathode current of 0.5 ampere.

Operating features of the RCA-6012 include a negative-control characteristic which is essentially independent of the ambient temperature over the range from −75° to +90° C, low preconduction currents, low control-grid-to-anode capacitance, and low control-grid current.

The RCA-6012 is compactly designed, and employs a structure that increases its resistance to both shock and vibration. A button stem is used to strengthen the mount structure and to provide wide inter-lead spacing as a means of reducing susceptibility to electrolysis and leakage.

For complete technical data on the RCA-6012, write RCA, Commercial Engineering, Section FR57, Harrison, N. J. . . . or contact your nearest RCA field office.

FIELD OFFICES: *(East)* Humboldt 5-3900, 415 S. 5th St., Harrison, N. J. *(Midwest)* Whitehall 4-2900, 589 E. Illinois St., Chicago, Ill. *(West)* Madison 9-3671, 420 S. San Pedro St., Los Angeles, Calif. Tmks. ®

Another **new RCA tube**

RCA-6080 is a current-regulator tube for use in regulated dc power supplies. Similar to the 6AS7-G, it features a button-stem construction for improved resistance to shock and vibration. The 6082, a companion tube for aircraft power supplies.

THE FOUNTAINHEAD OF MODERN TUBE DEVELOPMENT IS RCA

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